AD A115952

BULOVA SYSTEMS & INSTRUMENTS CORPORATION

28 July 1980

FINAL TECHNICAL REPORT

AUTOMATED INSPECTION MACHINE FOR MECHANICAL TIME FUZE COMPONENTS (MOVEMENT PLATES)

Contract No. DAAA26-76-C-0344

Submitted by:

M. Braverman
Senior Project Engineer

Approved by:

S.H. Sugarman, P.E.
Manager, Laboratory Services

DISCLAIMER NOTICE

BULOVA SYSTEMS & INSTRUMENTS CORPORATION
P.O. BOX 189, VALLEY STREAM, N Y 11582
TEL 516-561-2600 TWX 510-225-8409

13 April 1981
In Reply Refer: CA-AGS-837

Department of the Army
U. S. Army Armament
Research and Development Command
Dover, New Jersey 07801

Attention: Mr. Charles Guerriere
Procuring Contracting Officer

Subject: Contract DAAA25-76-C-0344
Automated Inspection System

Gentlemen:

Pursuant to the subject contract, we are forwarding herewith two (2) copies of the following report required under Contract Item No. 0003 for your information and retention:

FEASIBILITY STUDY
ADAPTATION OF
AUTOMATIC NON-CONTACT INSPECTION MACHINE
TO
INSPECTION OF M577 MTSQ FUZE LAMINAR COMPONENTS

Very truly yours,

Bulova
Systems & Instruments Corporation

A. G. Schmitt

A. G. Schmitt
Contracts Administrator

AGS/ev
Enclosures

cc: ARRADCOM, Dover, N. J. 07801
Attention: Mr. T. McKimm THIS COPY FOR
DRDAR-LCF-T Enc.

DCASMA, New York
Attention: Mr. St. Clair Reide, Sr., ACO
DCRN-GNCA-2

79

TABLE OF CONTENTS

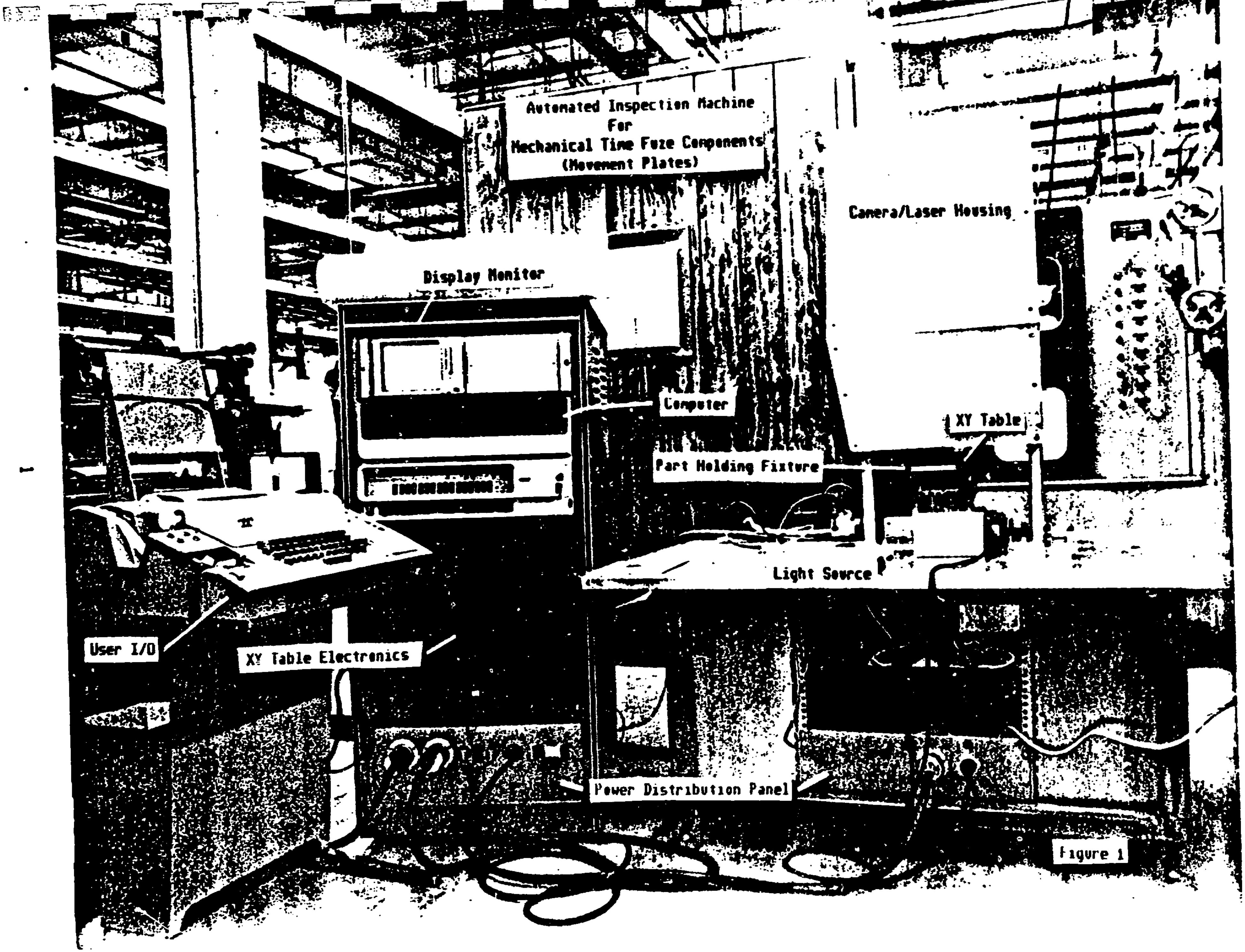

Automated Inspection Machine
For
Mechanical Time Fuze Components
(Movement Plates)
Camera/Laser Housing
Display Monitor
Computer
XY Table
Part Holding Fixture
Light Source
User I/O
XY Table Electronics
Power Distribution Panel

Figure 1

PREFACE

The implementation of successful high volume fuze manufacture depends, to a large degree, on the fast accurate reproduction of a workable prototype. Parts must be made to fall between acceptable tolerances to insure ultimate compatibility with all performance specifications. The process of insuring acceptable dimensional conformance is a costly process of detailed inspection, involving delicate complex gages and equipment. These inspection devices must be continually calibrated, repaired, and replaced due to physical wear and distortion. The use of inspection gages requires a high skill level and is tedious repetitive work. The time required for inspections for all but very simple parts and maintenance of the inspection gages preclude 100% inspection. In order to produce items in high volume, inspection is limited to a statistical sample (AQL level). Sampling inspection plans are a compromise between cost and the desired quality to perform the parts design function. The need for better inspection equipment to reduce inspection time, with non-wear characteristics, is a perpetual and recurrent requirement in fuze and ordnance manufacturing. Any improvement in the efficiency of the inspection operation would enhance the quality of the fuze product, decrease the manufacturing cost, and produce a desireable shortening of strategic lead time.

One significant attempt to improve inspection methods was conceived by U.S. Army Arsenal engineers during the manufacture of the M572 fuze. ~~If a completely~~ automatic non-contact inspection machine could be made for the fuze plate lamina, the goals of high quality and cost reduction could be realized as a result of this concentrated effort. With these goals in mind, Frankford Arsenal awarded Bulova Systems and Instruments Contract No. DAAA26-76-C-0344, for the development and fabrication of an automated Inspection Machine for Mechanical Time Fuze Components. The particular means of inspection was not limited to

This wa..

p. 4

any particular physical method or discipline. However, the piece of equipment to be produced was to allow for one hundred percent inspection and, if at all possible, use non-contacting measurement means. The machine was also limited to measurement of fuze plates on devices similar to the M572 fuze. This machine can inspect the M572 Plate No. 1, First lamina in 30 (thirty) seconds when the print out of inspection data is suppressed.

SUMMARY/CONCLUSIONS

After a concentrated design and fabrication effort, an optical inspection machine was made to satisfy the original scope of work. (See Figure 1) Monetary limitations and difficulties brought about by the closing of Frankford Arsenal, led to a situation that limited the ultimate development of the machine. Since it was foreseen under these conditions that project funds would ultimately be limited and/or terminated, work was discontinued on the automatic handling of the plate components. This was a practical approach for economy, since testing showed that a semi-automatic system gave better yield than a completely automatic handling system. All remaining funds were dedicated to the formulation of the measurement system with its associated hardware and software. Since the scope of work limited activity to inspection of relatively thin lamina, a "Z" axis requirement was eliminated at the very start of the program. The machine essentially demonstrated the capabilities required for non-contact inspection of the selected lamina. The measurements made yielded dimensional values that could be considered capable of being absolute if proper factors of proportionality could be added to the software. The existing program only accounted for one factor of proportionality. The requirement of a complex factor dependent on the optical scanning system was always present but never added due to a cut-off of software development because of funding restrictions. User programming difficulties also greatly limited the insertion of relatively simple embelishments into the software. Programming was done in machine language for economic reasons. Any higher level software system was beyond the original intent and funding capabilities alloted to the optical measurement system concept.

INTRODUCTION

On June 4, 1976, Bulova Systems & Instruments Corporation was awarded Contract DAAA26-76-C-0344 for the design and construction of a prototype Automated Inspection Machine for Mechanical Time Fuze Components. The initial concept for the prototype machine was conceived to embody a quantitization of optical signals to represent distances and compare these distances to acceptable tolerances.

Two modes of operation would be used. The first would quantitize the entire optical image of a lens system. The other mode would use the inherent accuracy of a precision X-Y table, together with optical transition signals to establish distances outside the field of view of the lens system. See Appendix C. Light sources were selected for direct and reflected illumination. Tungsten halogen lamps were considered for the source for the direct measurement. Experiments using various lens combinations and permutations for direct laser illuminations would also be tried. Low power, one milliwatt helium-neon lasers were considered for use as reflective non-contact depth measurement light sources. See Appendix E

The optical inspection machine included specifications for automatic piece part handling and positioning equipment. The handling equipment would have the ability of separating the rejected lamina into a separate bin from the accepted components as part of the automatic cycle. Two separate subcontracts were to be issued by Bulova Systems and Instruments Corporation to EMR Photelectric, a division of Weston Instruments Incorporated, and the PAF Design Corp. for the Optical Data Digitizer and the mechanical design of the automatic handling equipment.

The EMR Corp. would provide the major components of the digitizer which would include the image dissector camera, computer program, X-Y positioning table and inspection system software. The PAF Design Corp. would provide the complete mechanical design for the automatic handling equipment and camera and light system mounting hardware. All project management, integration and system design responsibilities would be handled by the Bulova Systems and Instruments Corp. Bulova would also provide all fabricated hardware and electrical control apparatus for the automatic handling equipment.

Subcontractors tasks were originally limited by monetary factors due to limitation availability of original funding. Consideration of additional funds at later dates was originally planned to allow for lower priority activity. The ultimate absence of these funds required the reallocation of funds from the (completion of the) automatic handling system to the (supplementation of effort on the) optical digitizer. Software funds were also limited from the very beginning. The entire software computer program was processed in machine language and done under a fixed price arrangement with the subcontractor.

DESCRIPTION

Physically the inspection machine was constructed in three units. The first and largest unit ~~(6 ft. high, 6 ft. wide, and 5 ft. deep)~~ was made as a complete unit for support of the camera system, X-Y table, viewing stage and automatic handling system. Heavy structural members support a one-inch thick table top which in turn serves as a mount for all mechanical components. The second major unit consists of a rack cabinet to house the Nova 3, Data-General Computer, the Anorad X-Y Table Electronics, the Power Distribution Circuitry and the Cathode Ray Video Monitor. The third unit consists of the input/output station, a model ASR 33 teletype machine.

As a complete system the inspection machine might be classified into the following parts. (See Appendix G)

1. Image Dissector Optical Data Digitizer System
2. Digitizer Power Supply
3. Tungsten Halogen Lamp Source with Heat Exchanger
4. Helium-Neon One Milliwatt Laser Reflective Light Source
5. Nova 3 Data General Computer with ASR 33 Teletype
6. Video Monitor
7. Anorad X-Y Table with Associated Electronics
8. Automatic Loader and Unloader w/Precision Lamina Holding Fixture
9. Texas Instrument 5TI Programmable Controller for Automatic Handling System
10. I/O Interface with Logic Modules
11. Software Package

The initial description of the intended operation of the machine diverges from the actual operation because of the non-completion of the automatic handling system. The actual operation consists of manually inserting two Plate #1 lamina into the precision holding fixture and measuring the front side of the first lamina and the back side of the second lamina. The fixture is then rotated 180 degrees and measurements are made of the front side of the second lamina and the back side of the first lamina. Measurements of the programmed holes, distances and features are then compared with dimensional limits in the computer. See Appendix B and C. A status report is made for each measurement and if all measurements are within limits, and "OK" light is illuminated.

The intended operation was to allow 200 plates to be magazine loaded and presented to the viewing optics one at a time. After inspection a plate is automatically removed and transferred either into an "accept" magazine or into a "reject" bin depending on the status of the lamina plate. The intended system was planned to afford interaction between the Nova 3 Computer and the 5TI programmable controller with a corresponding independence of machine sequence routined to optimize control requirements during normal operation and debugging periods.

Measurement capabilities of the machine are limited to the actual X-Y table resolution and accuracy. The specification of the particular Anorad table used was one tenth of a thousandth of an inch with a fifty millionths of an inch repeatability. Measurements could be made to these specifications if the optical digitizer was programmed to use the same coordinate elements for determination of a particular feature edge. The largest size hole that could be viewed, with the particular lens system used, was 250 thousands of an inch. If different parts of the optical viewing area for single frame digitizing are used, an error could occur due to linearity deviations caused by imperfect scanning components in this type of video camera system. Measurement errors due to this condition are presently below one thousandth of an inch.

This error is important if the machine is to be called an absolute measurement device. However, if the machine is rated as a comparator device the error becomes less important or even insignificant. A means of software compensation is possible to apply particular correction factors to all coordinate scanning points. Also a "pinhole" bezel with holes of known tolerance could automatically program the compensation factors if advanced programming techniques were to be used in the software. All of these software embellishments however were beyond the existing funding capabilities of the contract as written.

The system programming details that formulate the requirements for the entire scope of work are contained in Appendix A. Essentially this list is the basis for the computer block diagram. The computer block diagram was never supplied with the system due to the complexity of the task of documentation and constant updating requirement. Since the entire assembly language software package was developed by the optical digitizer manufacturer, there was very little opportunity for personnel external to that group to get a good grasp of the programming details. Money was not available for the special instructions and training necessary to enable user service contract for the software. See Appendix D.

DEVELOPMENT

One of the greatest problem areas seemed to stem from the use of an assembly language in the formulation of the software for this system. The entire success of the software, with absolute dependence on one or two individuals for insurance of proper operation, severely limited the inspection system. (See Appendix A) An initial recognition of this problem resulted in the use of an external controller for operation of the automatic parts handling system. The separate Texas Instrument Controller interchanged signals from the main Data General Nova 3 computer. The overall solution to computer language problem was also conceived very early in the program, but funding would not permit system implementation.

The recommended solution would be to write the entire program with formatted outputs in a high level computer language. All proprietary routines requiring special timing considerations would be treated as separate "black box" routines. These special routines could be accessed by the high level executive program and serviced by much more inexperienced programmers. These special routines could be executed in machine language, assembly language, ladder diagram language or even hard wired logic. It has been an interesting observation that most computer problems that have caused disruption to the continuity of the project have been traced to the executive assembly language program and never to the dedicated sub-routines. Since the machines executive program is written in assembly language, a simple manipulation of adding a printed comma becomes a formidable programming problem in the eyes of the average engineer user.

The solution of using a high level language for the executive program could be accomplished in two ways. First, incorporate the high level language into the Nova 3 System with corresponding changes in the memory system. Second, purchase an additional computer calculator with high level language and interfacing capability and incorporating this new interface into the system.

Another major problem area has been the primary light source. Originally a laser and diffuser were used as the primary light source. Despite the 250 mil field of view, unequal illumination caused severe errors in the system. Difficulties were encountered on light source alignment. Also, variations in intensity were noted as lasers aged. The solution to the problem was to install a 250 watt tungsten halogen lamp with a unique air heat exchanger system.

Almost all components of the material handling system were designed and constructed. However, the system was never assembled and tested. The system contained a special I/O interface specifically made to match the 5TI Texas Instrument Controller to the actuators and sensors of the automatic loader and unloader. The interface was designed to enable the operation of each actuator manually or automatically. Also, each actuator was able to be disconnected. LED pilot lights were incorporated to allow determination of each input or output level as a programming aid and during any trouble shooting sequence. The input sensors were also connected to allow automatic operation or manual level control. An initial ladder diagram program was developed and incorporated on the interfact, without using the actual loader and unloader hardware.

Specific inputs and outputs were designated on the Nova 3 and the 5TI for interactive usage. The materials handling logic is listed in Appendix A.

FUTURE DEVELOPMENT

Future development of similar inspection machines could incorporate various details that would overcome several present limitations. A basic change would be to use a solid state charge coupled diode pick up device with equal resolution compared to the present vidicon. If a pick up device of this nature were used, matrix scanning would eliminate scanning position error. Unlike standard electronic sweep image tubes, the diode matrix detector maintains each diode element in a time position in space, unaffected by electrical voltage variations. Computer error factors would be eliminated and the machine could become an absolute measurement device providing the optics did not introduce any distortion products. The inspection machine could work as it is working now, but with greater accuracy, without sacrificing any measurement speed.

To increase the versatility of the inspection device a third vertical, "Z" axis should be incorporated. At the present time the depth-of-field of lens system does not exceed the thickness of the lamina detailed in the scope of work. If a third depth axis were used with the associated optics, the machine would be adaptable to other fuze programs were the lamina or parts depths exceed the lens depth-of-field capabilities. With the incorporation of a "Z" axis, more flexibility could be achieved by using an automatic multiple turret lens head with selectable magnification for examination of many different types of piece-parts.

Depth measurements on the existing machine were successfully implemented by the use of the technique of splitting a laser beam on a projection or edge of a blind hole or crevice. See Appendix E. The ultimate use of this technique could be enhanced by allowing the attachment angle to be available in four or more different directions. This would require multiple lasers individually computer controlled. Additional software for the control routines would have to be developed. An alternate procedure to eliminate multiple lasers, would be to use a precision rotary table with programmable angular movement. If the rotary table were used, an alternate rotation-of-axis routine could be used to simplify the software. Mirrors could also be used to accomplish this end result.

Due to the span of time associated with the development of the inspection machine, a continuation of the project would certainly have to accommodate a change in the state of the engineering art of the two major building blocks of the system. The machine would have to be retrofitted with the latest advances in the computer field. It is then that the software could be adapted to allow simple restructuring of the program by the use of high level language techniques and perhaps separate microprocessor subroutines. The availability of a high resolution charge-coupled device image tube would necessitate new matrix scanning hardware and software.

MACHINE PERFORMANCE VERSUS SCOPE OF WORK

This machine as originally proposed was implemented and designed to conform to the requirements of the U. S. Government Contract No. DAAA-25-76-C-0344. The work on this project was complicated by the closing of Frankford Arsenal with its attendant administrative disorientation and change in cognizant Arsenal personnel during this closing period. Overall project effort was directed to satisfy the following document:

Technical Scope of Work

For
Automated Inspection of Mechanical Time
Fuze Components (Movement Plates)

Prepared by
Artillery Modernization & Engineering Division
Manufacturing Technology Directorate
Frankford Arsenal
Philadelphia, Pennsylvania
Dated 10 September 1975, Revision A

It must be emphasized that this machine was contracted as, and has always been considered, a prototype design whose ultimate use would be high volume precision measurement of fuze movement plates. It was envisioned that this design would serve as a basis for a group of production inspection machines strategically placed in a high volume manufacturing facility. While this individual machine was designed to satisfy this prototype requirement in concept, it was contracted to be a final piece of hardware for this purpose. The intent was to prove that the original study could be turned into hardware.

This report will attempt to establish the methods and hardware developed by Bulova to satisfy the technical Scope of Work pertinent to this particular project. Each item with its associated identification number will be discussed with regard to compliance, variances and problems referenced to the above Scope of Work.

Items 1.0, 1.1 and 1.2 are the general requirements for the machine that have been adhered to and are discussed in detail in later paragraphs.

In accordance with requirements, the outline drawings were obtained and a design was made to accept all M572 Fuze timer lamina. The fixture design was particularly adapted to Plate No. 1, the 1st lamina, per stated contractual requirement. Pertinent drawings for fixturing are described in Paragraph 2.1.

The equipment was designed to meet the following minimum requirements:

3.1.1.1 The equipment is capable of automatically inspecting any of the components listed in Section 2, to determine the diameters, depths, thickness and location of all holes, slots and grooves.

The computer limitation for the above capability is 32 holes and 32 features per side with two sides per program. A single feature is used for the determination of one slot location or one through groove location. Two features are used for one depth or thickness measurement.

3.1.1.2 The equipment has been primarily designed to inspect Plate No. 1 lamina, Drawing No. F105428/1. The inspection machine may be converted to inspect any of the components listed in Section 2.0, in a time not to exceed 8 hours. These conditions are true, provided that a suitable fixture were constructed and a software parameter loading tape made for the next plate to be inspected. No such additional fixtures were made as part of this project.

3.1.1.3 The equipment operates on 110v single phase 60 cycle power and requires an 80 PSI filtered air supply.

3.1.1.4 The design of the prototype machine has basically been adapted to the requirement of inspecting 100 piece parts an hour. This rate could be obtained with the proposed automatic loading and unloading equipment. However funding for this job, and Arsenal technical project direction dictated the use of "program to user" to solve a number of basic optical problems which were more important than the part handling completion. The program controller and associated input and output circuitry were constructed and the control program was successfully implemented and demonstrated.

While the cyclic rate for 100 parts per hour was simulated the machine was never put through continuous testing at this rate. However, it was determined with Frankford Arsenal Quality Engineers that the rate could approach 130 pieces per hour.

3.1.1.5 Feeding of components for the automatic machine was demonstrated by the use of hand loaded magazines.

3.1.1.6 It is felt that the fundamental criteria of utilization of non-contact gaging techniques has been met by this project effort. An image dissector scanning tube together with a high intensity halogen light source and a low power helium laser form the basis of an optical intelligence system that enables the measurement of holes, slots and depths without any physical contact. The unique system of utilizing a split laser beam, divided by the edge of a blind slot or hole edge, permits the determination of depth by measuring the relative displacement of the split laser beam separation.

3.1.1.7 All material handling components that come in direct contact with the components to be inspected are replaceable.

3.1.1.8 The equipment was designed to operate continuously for at least 16 hours per day at the rate specified in 3.1.1.4.

3.1.1.9 The equipment is capable of both static and dynamic calibration. This may be accomplished by introducing high limit and low limit plates into the system. Project funds were not made available for the construction of these limit plates. Calibration has been checked by noting the actual deviation from calibrated plates with previously measured hole sizes and known feature positions.

3.1.1.10 The equipment was designed within 10% of the tolerance of most of the characteristics to be inspected. In case of the exceptions where a larger percentage of the tolerance was chosen, a compromise was established to allow for expenditure of funds in the direction of the feasibility of the total non-contact measurement in preference to the expense of hardware with one more magnitude of resolution. However, with proper programming the gage tolerance may be taken in the direction of the rejection.

Essentially the specifications formulated in this paragraph together with the ability to consistently meet these specifications determine the success of the ultimate production machine.

Several factors permitted variations to decrease the ultimate reliability and repeatability of the hardware originally conceived for this project. The chief problem has been attributed to the variation of position of the scanning field associated with image dissector instrumentation. The viewing field is a function of tube emission, voltage variations and yoke temperature variations. Size and linearity will adversely affect the accuracy and repeatability of any given measurement over an extended period of time.

To overcome some of the image dissector variations, greater physical magnification could be used to measure a hole in sections, by having the edge cover the whole field of view of the camera. A movement of the positioning table to another position to view the opposite edge would yield a measurement that could reduce all errors to the accuracy and resolution of the x-y table. The disadvantage of this method is the time it takes to make a measurement, since slower mechanical movements are used instead of electronic scanning.

The ultimate solution involves the procurement of a new optical transducer with a video element similar to a charge coupled photodiode. This device should have the same horizontal and vertical resolution as the image dissector and be scanned with a large scale, integrated, matrixing, sweep arrangement under computer control. Since the picture element photodiode is physically fixed in the field of view, the inaccuracy due to the drift of the magnetic scanned devices is eliminated.

During the period of development of this machine, a new generation of solid state cameras has evolved and shown great promise to overcome instabilities that contribute to deterioration of accuracy with magnetic or electrostatic scanned devices. At the time that this program was implemented, the above technical approaches were considered "state of the art" and contributed to development considerations for the present generation of instruments. To some extent, the Frankford Arsenal closing situation allowed obsolescence due to inordinately long periods of cognizant contractual approvals, as well as the necessity of acquainting new government people with the program.

3.1.2 Reliability, Availability and Maintainability (RAM) Requirements.

3.1.2.1 The inspection machine was operated for a period of 8 hours per day for a cumulative running time of more than 40 hours to test out various (RAM) requirements. These tests were conducted under direction of U. S. Government engineering personnel from Frankford Arsenal.

3.1.2.2 The Mean Time Between Failures (MTBF) of the inspection machine was shown to be greater than 6 hours and 45 minutes under a specific program taking into account all useable hardware and software.

3.1.2.3 The Mean Time To Repair (MTTR) of all useable hardware and software is less than 45 minutes if adequate replacement components are immediately available.

3.1.2.4 The inspection machine will not accept more than one out of tolerance plate of each 1000 out of tolerance plates, as the Scope of Work requires.

3.1.2.5 The inspection machine, due to electro-optical instabilities, might reject more than one in-tolerance plate of each 1000 in-tolerance plates at this stage of development.

3.1.3 The basic design concept was reviewed by the Government representatives and the design details for the prototype machine were established.

3.2.1 The Bulova Systems and Instruments Corporation has performed all actions necessary to fabricate and assemble the prototype automatic equipment for the dimensional inspection of the fuze movement plates listed under Section 2.0 of the Technical Scope of Work and within the framework of allocated funds and engineering priority directives.

3.2.2 Improvement and adjustments found necessary during fabrication were made and incorporated into the Technical Data Package by Bulova.

3.3.1.1 A Government representative has observed the functional operation and testing of the machine, consistent with the considerations agreed to by the Government and Bulova. The following information outlines the specific tests required by the Scope of Work under Section 3.3.1.2 and 3.3.2. They are reproduced here for convenience.

3.3.1.2 One hundred (100) No. 1 Plates, 1st lamina, which will be provided by the Government, will be processed through the Automatic Inspection Machine. These plates will be recycled as necessary to meet Section 3.0 requirements. The supplied plates will be 100% inspected by the Government and an inspection report will accompany the plates. Each plate will be identified for referencing with the inspection report and a predetermined number of plates will have selected features out-of-tolerance.

3.3.2 The Government will verify that the requirements of this Scope of Work have been met by subjecting the inspection equipment to the above test. Data collection will be determined by the Government to provide adequate information for necessary analysis and evaluation.

Due to the closing of Frankford Arsenal (Item 3.3.1.2) the tests outlined above were not performed. One hundred (100) calibrated plates were never made available. The data collection called for was not obtained or analyzed. However, the machine was subjected to testing by Government engineers from Frankford Arsenal and Picatinny Arsenal and was found to be operating in the manner described previously. (See Appendix F.) Also an additional effort was funded to study the adaption of this machine to plates on a different fuze program with a corresponding change in fixtures and programming. The study, if successful, could lead to a testing program with the new fuze plates instead of the old since circumstances prevented the completion of the original test program.

3.4.1 At the present the Technical Data Package includes all data developed, and an operational manual and maintenance information. Drawings of the inspection machine are made in commercial format. Documentation appears sufficient for this prototype machine. However, if a new improved machine is constructed, at some later date, a separate documentation revision should be made and an overall separately funded effort should be made for a completely integrated manual accounting for the cost of technical writers, manual preparation and duplicating materials.

3.5.1 Contract Implementation Schedule in accordance with Scope of Work was delayed due to various factors. Vendor delays were reported and the closing of Frankford Arsenal with associated project management changes during the closing resulted in significant slippage in calendar time.

APPENDIX A

ENGLISH PROGRAM DETAILS
AND
LOAD/UNLOAD SEQUENCE

BULOVA SYSTEMS & INSTRUMENTS CORPORATION

FIGURE 1

ENGLISH PROGRAM DETAILS

Plate No. 1 **First Lamina** **Side 1** **Part 10542821**
Name INS **Left Side**

1.	Insert Lamina					
2.	Orient Lamina					
3.	Hole A Routine determine axis, center of hole, diameter 0/0					
4.	Move table to	B	-.7460,	1.1968	Measurement Routine (MR)	
5.	(MT)	D	-.3740,	.5984	(MR)	
6.	(MT)	N	-.3740,	-.0709	(MR)	
7.	(MT)	8	-.2604,	+.8565	(MR)	
8.	(MT)	11	+.0450,	+.3229	(MR)	
9.	(MT)	12	+.2285,	+.7559	(MR)	
10.	(MT)	14	-.2835,	+.6494	(MR)	(CHORD)
11.	(MT)	20	-.2661,	+.4153 (Ref)	(MR)	(SPECIAL POSITION)
12.	(MT)	22	.2760,	+.4034	(MR)	
13.	(MT)	26	-.7840,	+.0717	(MR)	
14.	(MT)	34	-.4645,	+.5474	(MR)	(CHORD)
15.	(MT)	35	-1.0240,	+.7934	(MR)	
16.	(MT)	45	-.8505,	+1.0589	(MR)	
17.	(MT)	48	-.4450,	+1.1694	(MR)	
18.	Light #2 Change					
19.	(MT)	83, 85, 88			(MR)	CONTOUR
20.	(MT)	84, 86			(MR)	CONTOUR
21.	(MT)	90	-.4522,	+.0613	(MR)	
22.	(MT)	91	-.5610,	+.1311	(MR)	
23.	(MT)	103	-1.0540,	.4264	(MR)	
24.	(MT)	Side Hole			(MR)	with mirror
25.	(MT)	Main Diameter			(MR)	
26.	(MT)	Edge Hole adjustment slot AA stot			(MR)	

Plate No. 1 First Lamina Side 2 Part 10542621

1.	Move table. Rotate fixture.			
2.	Reorient Lamina			
3.	Hole A Routine determine axis, center, of hole diameter 0/0			
4.	Move table to	B	(MR)	
5.	Move table to	D	(MR)	
6.	Move table to	N	(MR)	
7.	(MT)	8	(MR)	
8.	(MT)	11	(MR)	
9.	(MT)	12	(MR)	Counter Bore
10.	(MT)	14	(MR)	Diameter chord
11.	(MT)	20	(MR)	Critical center
12.	(MT)	22	(MR)	
13.	(MT)	26	(MR)	Counter Bore
14.	(MT)	34	(MR)	Chord
15.	(MT)	35	(MR)	
16.	(MT)	45	(MR)	Counter Bore
17.	(MT)	48	(MR)	
18.	(MT)	90	(MR)	
19.	(MT)	91	(MR)	
20.	(MT)	103	(MR)	
21.	(MT)	Large thru slot. Spin Detent.	(MR)	
22.	(MT)	Small thru slot. Spin Detent.	(MR)	
23.	(MT)	Large thru slot. Self Starter.	(MR)	
24.	(MT)	Small thru slot. Self Starter.	(MR)	
25.	(MT)	Section "BB". Slot dimensions and depth.		
26.	(MT)	Edge Square	(MR)	Linear
27.	(MT)	Adjusting Block slot	(MR)	Linear
28.	(MT)	Spin Detent slot	(MR)	Contour Depth
29.	(MT)	Large oblong	(MR)	
30.	(MT)	Small oblong	(MR)	
31.	(MT)	Self Starting slot	(MR)	Contour Depth
32.	(MT)	Large oblong	(MR)	
33.	(MT)	Small oblong	(MR)	
34.	(MT)	Contour center land D hole	(MR)	
35.	(MT)	Main diameter	(MR)	
36.	(MT)	Thickness	(MR)	
37.	(MT)	Reorient Lamina		
38.	(MT)	Remove Lamina		
39.	(MT)	(Sort Lamina)		

A SYSTEMS & INSTRUMENTS CORPORATION

FIGURE 2

LOAD / UNLOAD SEQUENCE

AUTO INSPECT MACHINE

Switch	1	Tray in Position
———		
Switch	2	Lift Rack Down
Switch	3	Lift Rack Up
Solenoid	4/5	Lift Rack Cylinder
———		
Switch	6	Extended
Switch	7	Retracted, also empty compression
Solenoid	8/9	Part Unloader Cylinder
———		
Switch	10	Position, Bottom Detector
Switch	11	Position, Top Detector
———		
Switch	12	Extended Position
Switch	13	Retracted Position
Solenoid	14/15	Transfer Cylinder
———		
Motor	16	Vertical Position
Motor	17	Top Horozontal Position
Motor	18	Bottom Horozontal Position
———		
Solenoid	19	Air Blast
———		
Switch	20	Extended Position
Switch	21	Retracted Position
Solenoid	22/23	Slide Deposit Cylinder
———		

Switch	24	Deposit in Placement Position
Switch	25	Placed on Orientator

Switch	26	Orientator in Load Position
Switch	27	Orientator Locked

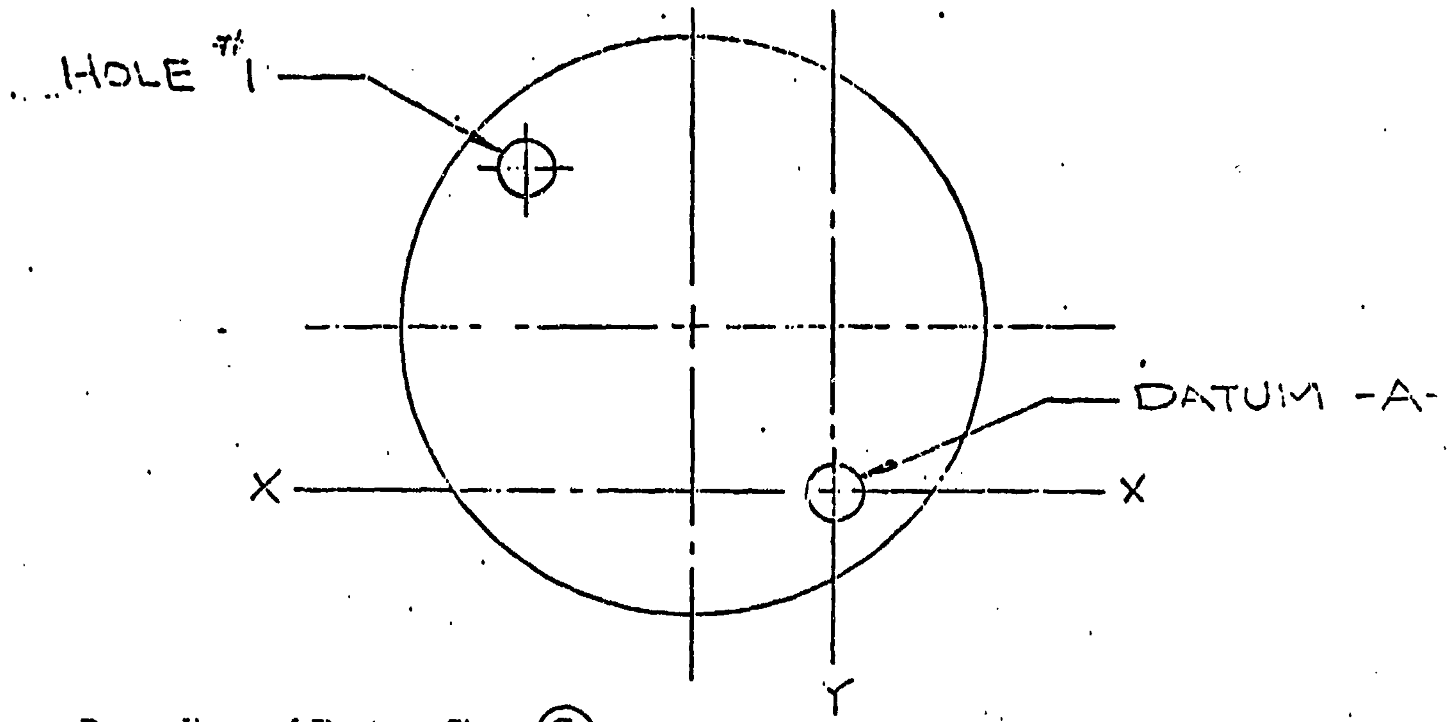
Sensor	28	Piece Part in Nest Position. Move to Inspect.
Sensor	29	Rotate 180 Degrees
Sensor	30	Locked Nest Rotation
Sensor	31	Open Nest to Rotate
Solenoid 2-way	32/33	Lock and Open Nest Air Cylinder
Sensor	34	Insert Position Lock
Sensor	35	Pin Extended
Sensor	36	Pin Retracted
Sensor	37	Piece Retracted
Sensor	38	Piece Part in Retract Arm
Sensor	39	Piece Part Retracted Position
Solenoid	40/41	Air Cylinder Retract Parts
Sensor	42	Part in Position for Pickup to mount on Position Shuttle
Solenoid	43/44	Air Cylinder Stack
Sensor	45	Stack Shuttle Cylinder Extended
Sensor	46	Stack Shuttle Cylinder Retracted. (Shuttle Full)
Solenoid 2-way	47/48	Lift Rack Cylinder
Sensor	49	Lift Rack Up
Sensor	50	Lift Rack Down
Solenoid 2-way	51/52	Air Cylinder Eject Bad Position
Sensor	53	Ejector Extended
Sensor	54	Ejector Retracted
Tray	55	Position to receive Parts
Tray	56	Full ?
Tray	57	Empty ?

APPENDIX B

TRUE POSITION TOLERANCE

True Position Tolerance Considerations

The inspection machine has the capability of allowing position tolerance conditions to be satisfied in accordance with two standard acceptance techniques. An "S" or an "M" feature designation is selectable by proper input instructions with the HTAG1" and "HTAG2" the system commands for the 2 nests which accept the top and bottom surfaces respectively of the test specimen. The following two measurements Regardless of Feature Size "S" and Maximum Material "M" are described in the following two pages.



Regardless of Feature Size (S)

Step 1 Measure hole size of Datum-A-. If within hole tolerance, proceed.

Step 2 Center hole.

Step 3 Move to hole #1.

Step 4 Measure hole size of hole #1. If within hole tolernace, proceed.

Step 5 Center hole #1.

Step 6 Measure X&Y co-ordinates

Step 7 Compare with data for nominal position.

Step 8a) If data in step 7 is same as nominal data record X&Y co-ordinates in Step 6.

Step 8b) If data in step 7 is different than nominal data do the following:

Take difference of X&Y co-ordinates and calculate true position

$$Z=2\sqrt{X^2 + Y^2}$$

Step 8c) Compare Z in step (8b) with drawing true position tolerance.

Maximum Metal (M)

Step 1 Measure hole size of Datum-A-. If within hole tolerance, proceed.

Step 2 Center hole.

Step 3 Move to hole #1.

Step 4a) Measure hole size of hole 1. If within hole tolerance record actual size and proceed.

Step 4b) Add difference between min dwg size and actual hole size to positional tolerance.

Step 5 Center hole 1

Step 6 Measure X&Y co-ordinates.

Step 7 Compare with data for nominal position.

Step 8a) If data in step 7 is same as nominal data record X&Y co-ordinates in Step 6.

Step 8b) If data in step 7 is different than nominal date do the following:

Take difference of X&Y co-ordinates and calculate true position (Z)

$$Z=2\sqrt{X^2 + Y^2}$$

Step 8c) Compare Z in step (8b) with (Step 4b) true position tolerance.

Example #12 Hole

	Hole	X	Y	Posn. Tol.	Hole Size	Diff. of Hole Size
DWG REQ'T	12	.2285	.7559	.0056 M	$.143 {}^{+.005}_{-.000}$	
ACTUAL	12	.2288	.7556	Z=.00085	.1462	.0032

1-Check hole Dia. (.1462)

2-Add difference between drawing (MIN) nominal hole seze and actual hole size to drawing position tolerance. (.0032 + .0056=.0088)

3-Compute actual position tolerance (Z)=.00085

APPENDIX C

HOLE AND FEATURE MEASUREMENT TECHNIQUES

GENERAL

All linear measurements are made using a software program which causes a line scan across any selected area of a part. As the scanning point passes through an intercept on the part being inspected, this intercept is stored as a digital address in the computer memory. After this single line scan is complete, the computer calculates the straight line distance between two points or intercepts of interest and displays or stores this dimensional information in units of inches or millimeters as calibrated.

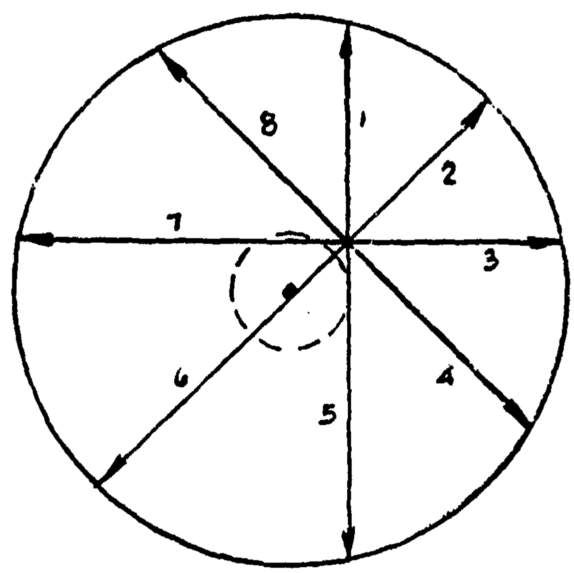
An intercept is a transition from a light area to a dark area. Two intercepts are needed to form the length of a line by calculating the straight line distance between the transition points. Any edge or transition may be defined as a feature. A combination of transitions may also be defined as components of a feature. Each component must have assigned limits for tolerance determination. A non-circular hole may be inspected as a combination of transition points and accepted in this manner.

HOLE MEASUREMENT

A hole measurement is made by a routine first determining four chord lengths of a hole feature within the optical field of the digitizer camera. These chord lengths are at an angle of 45 degrees to each other. Proprietory routines within the computer analyze the digitized optical results and determine a hole center. Once the hole center is determined, another routine determines the length of four diameters through the derived hole center. The quantitized diameter lengths are then processed to be presented as a four diameter or averaged diameter under program option control.

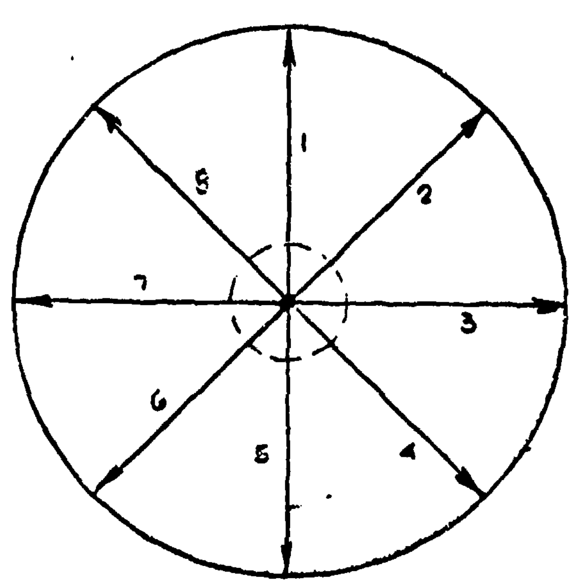
The operation of the Comp - Gage optical inspection head is described in greater detail in Appendix D.

HOLE MEASUREMENT DIAGRAM



HOLE CENTER
DETERMINATION

HOLE MEASUREMENTS
COMPUTER ROUTINE OPTIONS



HOLE MEASUREMENT
WITH DERIVED CENTER

1. D_1, D_2, D_3, D_4 } AVERAGED

   DT AVERAGE
   HOLE DIAMETER

   OHL — FAIL
   ACCEPT
   ULL — FAIL

2. D_1 DIA.

   D_2

   D_3

   D_4

   OHL — FAIL
   ACCEPT
   ULL — FAIL

APPENDIX D

COM-GAGE OPERATION GUIDE

4/5/77
SERIAL 7

COMP-GAGE OPERATION GUIDE

Operation of the COMP-GAGE is logical and uncomplicated. In general, normal conversational words are used to direct it through various learning and inspection stages.

The COMP-GAGE possesses core memory and uses paper tape and a teletype reader to acquire intelligence and perform analytical tasks.

Under normal operating conditions, the computer will retain its memory even with a loss of power, but if for any reason should the memory be lost, reloading the program is simple and follows these basic steps:

1. Place the power switch key to ON.
2. Move teletype reader switch to FREE.
3. Position program loader tape on the feed holes and thread into reader.
4. Position tape leader until loader tape feeds to just before the punched holes.
5. Place all numbered octal switches DOWN, and the teletype reader switch on START.
6. Set octal switch 12 UP.
7. Depress program load switch.
8. When the tape stops, remove tape and place tape reader switch to FREE. (Should the tape jam or foul while reading, depress STOP button, rearrange tape and depress CONTINUE switch to finish reading).
9. Place COMP-GAGE program tape in the reader and prepare it in the same manner as the loader tape.
10. When the tape is ready for reading, place all numbered octal switches in the up position except switch Ø and 1 (37777 octal) = 16 K) must be down.

11. Depress START (tape will feed).

TAPE
IF STOPS
check for 27_8
on readout.
If there run tape
from start.

12. After tape is read and removed, load the next sequential COMP-GAGE program. If finished, go to step 13 and the COMP-GAGE system should be ready for operation. If not, load next tape and go to step 11.

13. Place all octal switches down.

14. Place 7 and 10 octal switches up (440 octal).

COMP-GAGE is ready for operation.

ATRACE: A Trace

This command causes the scanning system to perform an A-Trace measurement horizontally across the center of the scanner's field. An oscilloscope must be used to monitor the X position vs Z data intensity. As an example, scanning from right to left over an edge (light to dark) in a half white, half dark field, an A-Trace would appear as follows:

The sharper the transition slope, the better the focus. To exit, simply depress any teletype key and the prompt will return and the A-Trace will cease.

AUTO: Automatic Inspection Mode

This command automatically runs the currently trained instructions to perform the requested measurements any number of times on the inspection system. Once this command has been issued, the teletype will respond with AUTOMATIC INSPECTION. This tells the operator that the automatic mode is active. To start measuring, the operator must type the command RUN (see RUN COMMAND). The system will sequence through without interruption, initiating printouts as selected through the TYPE commands, and determining FAIL or PASS conditions on the present part. In order to exit this mode, simply block

SANGAMO WESTON
Schlumberger

the part so that light cannot pass through the datum holes and the system will return to the prompt. In order to delete AUTO operation, type MANUAL, and see MANUAL command instructions. SIDE1, SIDE2, MANUAL, BYPASS and AUTO are all related commands.

BYPASS: Bypass Instruction

This command is used for system checkout of the load sequence. After typing BYPASS, the system will respond with BYPASS "ON". The operator now types RUN. The system will now sequence as follows:

(1) Drive table to true HOME position.
(2) Drive table to initial set position for loading
(3) Waits until SIDE 1 ready initiates
(4) Retracts table
(5) Side 1 done pulses
(6) Side 1 OK
(7) Waits until Side 2 ready initiates
(8) Side 2 done
(9) Side 2 OK
(10) Prompt returns for operator

To exit the BYPASS mode, see RESET command.

Make sure ISET and RSET have been previously issued before using BYPASS.

CENTER: Center Boresight Cross

This command simply places a center marker cross on the monitor system or oscilloscope to physically center the boresight to some reference. Striking any teletype key exits back to the prompt.

CLOSE: Close Upper Laser Shutter

This command allows the operator to control the upper laser height measuring shutter through a teletype input. In this case, the shutter will close if opened or remain shut if closed. See OPEN command.

DATA: Data Output

This command allows the operator to typeout all the currently measured data from the last part measured. Only those items specifically trained for inspection will output. Upon completion the operator prompt (*) will return.

SANGAMO WESTON Schlumberger

DEBUG: Debugger

This command allows the operator to enter the resident debug program. To operate this feature consult the Data General Debug II User's Manual 093-000020-03 for a complete description of system modification. This program provides for four active breakpoints within the user's program. The accumulators, carry, and memory locations can be examined and modified from the teletype. The machine state can be monitored during execution using simple commands. In addition, this program will punch ranges of memory in format acceptable as input to the binary loader and perform desk-calculator type expression evaluations. In order to exit back to your program from this routine type 44ØR. The prompt will be restored.

DIST1: Distance Analysis Side #1

This command allows the operator to output the currently measured distances for side #1 on the teletype. The return will be back to the operator prompt.

DIST2: Distance Analysis Side #2

Same as DIST 1 except for Side #2.

DRIVE: Drive XY-Table to Position

The DRIVE command allows teletype control of the XY-table movement as specified by the XYTABLE command.

FDATA1: Feature Data Side #1

This command allows feature data for a specific number to be analyzed. The operator issues FDATA1. The system responds with FEATURE #. Any number from 1 to 32 is allowed any other number greater than 32 or an alphanumeric will cause return to the operator prompt. All legal numbers are terminated by a carriage return. The selected output will then type out. The header information appears only once and the sequence of inputs will repeatedly occur until the operator wishes to exit this mode.

FDATA2: Feature Data Side 2

Same as for FDATA1 but now for Side 2.

FLOC1: Feature Location Specification Side #1

This command allows the operator to input the starting and ending address of a feature line directly into the system memory. Upon typing this command, the system will respond with SIDE #1 FEATURE #. Any number from 1 to 32 is acceptable, all other number or characters will cause a return to the system prompt (*). After typing the number, type a carriage return. The system will respond with the following abbreviations:

SAX:	Starting address in X
SAY:	Starting address in Y
EAX:	Ending address in X
EAY:	Ending address in Y

After SAX: the system will print the present value followed by a comma. The new value is then input with either + or -, the decimal point need not be input for integer inputs, type only those numbers needed followed by a carriage return. The system will sequence through the same responses for SAY, EAX and EAY. If you should make an error while typing your new number, depress the RUBOUT key and then type in the new entire number. The RUBOUT key may be used an indefinite number of times on a line. If you do not want to modify an opened address, then simply strike the ESC key and the current contents will remain intact. Exit from this mode has been previously described.

These inputs are the two points between which the scanner will determine where the selected feature exists on the straight line between (SAX, SAY) and (EAX, EAY) coordinates.

FLOC2: Feature Location Side #2

This command is the same as FLOC1 except that inputs for side 2 are entered.

FTAG1: Feature Tag Side #1

This command allows the operator to select an alphanumeric tag for each feature input for easy measurement recognition on the printout. Any keyboard character is allowed except carriage return which terminates the input string of up to six characters. The preferred method of input is very simple. Upon typing, FTAG1, the system will respond with TAG ID #. Any number from 1 to 32 is legal. These numbers correspond to those selected when using FLOC1 or FLOC2 commands. After the number is input, follow it by a carriage return. The system will respond with:

NOW: XXXXXX NEW:

The current tag is printed after NOW: and the system waits for a NEW: input from the teletype. Type in the new tag. If less than six characters, type spaces until the system prompts again. Any illegal number or key following the TAG ID # query will return the system prompt.

FTAG2: Feature Tag Side #2

Same as for FTAG1 except for side 2 printout tags.

HDATA1: Hole Data Location Analysis Side #1

Same as for FDATA1 except for holes instead of features for side 1.

HDATA2: Hole Data Location Analysis Side #2

Same as for FDATA1 except for holes instead of features for side 2.

HIGH#1: Height of Depth Control for Side #1

This command allows the operator to analyze features with the overhead laser to measure depths on the part surfaces. All features should be entered consecutively through the FLOC1 command. This command allows the operator to select where, after all features have been analyzed, the following features will be interpreted as depths with the use of the upper laser system. When this command is issued, the system responds with:

HEIGHT #1 COUNT BEGINS AT FEATURE #

The operator answers with the tag number where the depth measurements will occur followed by a carriage return. The numbers must be between 1 and 32. For no depth measuring type in 32. The system will return the prompt after the number is input.

HIGH#2: Height of Depth Control for Side #2

Same as for HIGH#1 command except Side 2 count is input.

HLOC1: Hole Center Location Side #1 Inputs

This command allows direct input of hole center locations to system memory. The system responds with HOLE # and waits

SANGAMO WESTON Schlumberger

for a legal input as described previously in FLOC1. After a legal input, the system asks for XC and YC.

XC = X-center location
YC = Y-center location

After either XC or YC, the system will printout the current values resident therein and await a new input. (See FLOC1 for input discussion).

Any illegal number or alphanumeric answer to HOLE # will exit to the system prompt *. Holes 1 and 2 determine the datum line correction and must be entered before any system operation can occur.

HLOC2: Hole Center Location Side #2 Input

Same as for HLOC1 except for Side 2 inputs.

HOME: Home XY-Table Position

This command causes the XY-table to return to its home position.

HTAG1: Hole Tags Side #1

This command executes exactly like FTAG1 except that hole tags are input for Side #1.

P in first position governs printing of that line. An S or M in the second position designates the hole measurement types.

PS,#12 means print, S-hole #12

HTAG2: Hole Tags Side #2

Same as HTAG1 except for holes.

INITIAL: Initial Load Position

This command causes the XY-table to proceed to its initial position as specified through the ISET command. The initial position is initially set at point (1, 1) inches when the program is originally loaded.

SANGAMO WESTON
Schlumberger

ISET: Initial Set Position

The ISET command allows the operator to program the XY-table to an initial position for loading. The ISET command when issued makes the current values specified under the XYTABLE command or its current location to be saved permanently as an initial position. After this command is typed, the system response will be LOAD POINT SET, and return to the operator prompt *.

LOCATE: Locate Present XY-Table Position

This command causes the system to printout the current XY-table location.

MANUAL: Manual Mode

This command is used in conjunction with the AUTO command to allow one pass measurement of both sides and then stop for further commands. When this command is issued the system will respond with MANUAL INSPECTION, and return for more commands. This mode will remain set until the AUTO command is issued to change modes. The normal mode upon system initialization is manual at program read in time.

NORMAL: Normal XY-Table Operation

This command allows the XY-table to have its measurements referenced to true HOME position. When the system is initially read into memory, NORMAL is the usual mode.

OFFSET: Offset From Home Operation

This command allows the operator to not use the home position of the XY-table as a reference but another point on the table declared as (0, 0) offset from true home. The offset operation allows the operator to directly enter locations into the system memory from the part drawing. The only points that must be determined are the initial point and the location of the first datum hole with respect to the true home location. Once these are found, all other measurements will be relative to the first hole of each side. The system will respond with OFFSET "ON" when this command is issued.

SANGAMO WESTON
Schlumberger

OPEN: Open Laser Shutter

This command causes the upper laser shutter to open and stay opened until either closed by the CLOSE command, or causing the XY-table to drive. The system does not print any response to this command but the shutter will open.

PUNCH: Punch Trained Information Parameters

This command allows paper tape punching of the trained information within the system for retraining the system, the exact same way at a later date. The PUNCH command is issued and the computer will halt allowing time for the operator to turn on the punch located at the left hand side of the teletype. If some leader is desired, place the teletype switch on LOCAL, turn punch on, depress the "HERE IS" key until the desired length is reached. Put teletype switch on "ON LINE". Depress the CONTINUE switch on the computer switches and the system will make a binary tape of the pertinent information. When completed, the computer will again halt. Turn off the punch and depress CONTINUE. The system prompt * will return.

If the operator desires to stop punching at anytime, placing Bit Ø "ON" via the panel switches will cause the system to return to the operator prompt. The system will return only after the current data block is finished punching.

RDOS: RDOS Return (RDOS ONLY)

This command allows the operator to return to an RDOS operating system. The operator must then hit CTRL-A or CTRL-C for exiting. This program command will appear to make the system inoperative in an SOS environment. Just STOP and START the program again.

READ: Read Binary Tapes Into System

This command allows the operator to read binary tapes via the teletype reader. The NOVA program loader must be resident. Load the binary tape into the reader, set SW = 37777, type READ, and the system will automatically read the binary tape and halt when finished. Place the starting address of this program on the NOVA switches ($44Ø_8$) and depress START. The system is again operative with the new information just read in present.

RESET: **Reset Bypass Switch Mode**

This command causes the BYPASS mode command to be reset for normal measurement operation. After issuing this command, the system responds with BYPASS "OFF" and returns the prompt. See the BYPASS command for initialization and operation of this mode.

RETRACT: **Retract XY-Table**

This command should be issued only after RSET has been initialized. After this command is issued, the system will respond with no confirmation but the XY-table will proceed to the preset retract point for part manipulation. The system prompt will automatically return when retraction is complete. See XY-table command and RSET for setting this position.

RETRAIN: **Retrain Datum Line Angles**

This command causes the system to reset all datum calculations for positioning to zero, and allows the operator to make another or new pass with new datum corrections. The system will respond with ANGLES RESET.

RSET: **Retract Point Set**

This command operates exactly like ISET except the retraction point is set and the system will respond with RETRACT SET. See ISET for transferring values from XYTABLE via RSET.

RUN: **Run Mode**

This command starts the measuring sequence:

(1) XY-table goes to home
(2) XY-table goes to ISET position
(3) Waits for ready signal for Side 1
(4) Moves to first datum hole
(5) Measures the center and four diameters
(6) Moves to second datum hole and does (5)
(7) Computes datum line angle and position
(8) Measures all remaining holes
(9) Measures all remaining features
(10) Measures all remaining depths

(11) Outputs information if desired
(12) Retracts to RSET position
(13) Gives out side 1 OK or fail signal and side 1 done
(14) Wait for side 2 ready signal
(15) Repeats steps (4) to (11) except for side 2 data
(16) Repeats steps (13) and (14) except for side 2 data
(17) If in manual mode, the system returns to *
(18) If in automatic mode, go to (1)

The system will also return to itself if an error message is encountered.

SCAN: Scan 256 x 256 Real Time Raster

This command allows the operator to cause the scanning system to display a real-time picture of the scanning area on an oscilloscope or monitor for visual verification. The scanners rate is 5 frames/sec. with 256 x 256 points/frame. To exit this mode, the operator simply depresses any teletype key. The system prompt will then appear as the scanning stops.

SIDE1: Side 1 Start

This command simply allows Side 1 measurements to immediately start with no initial position movement or external signalling. The program will measure Side 1 and then wait for signalling for Side 2.

SIDE2: Side 2 Start

This command directly runs Side 2 measurements with no external signalling and returns to the system prompt when completed.

STOP: Stop Program

Issuing this command will cause a total program halt. To return, simply depress the console CONTINUE switch. The system is now again operational.

TDIA1: Tolerance Diameter Side 1

When this command is issued, the system will respond with HOLE SIDE #1 TOL. # and await for a number from 1 to 32 followed by a carriage return. Any other character will exit to the system prompt. If a legal number is typed, the

SANGAMO WESTON
Schlumberger

operator may now type the lower and upper tolerances on that hole diameter number. The inputs are the same as those described previously under FLOC1.

TDIA2: Tolerance Diameter Side 2

Same as TDIA1 except for Side 2.

T4DIA1: Tolerance 4 Diameter Holes for Side 1

This command allows separate inputs for 4 diameter tolerance analysis on holes 1, 2, 3 and 4. Each diameter, taken at 45° from each other, are individually toleranced against this input tolerance. This command responds with HOLE 4-DIA TOL# and awaits for a 1 to 32 input followed by a carriage return. Inputs are the same as for TDIA1.

T4DIA2: Tolerance 4 Diameter Holes for Side 2

This command is exactly the same as T4DIA1 except for Side 2 measurements.

TFLOC1: Tolerance Feature Location Side 1

This command allows the operator to enter feature tolerances to both the X and Y position of the feature coordinate. The system will respond with FEATURE SIDE #1 TOL# and await for a 1 to 32 input with a carriage return. The system will respond with X-LOW: +X.XXXXX, and await inputs as discussed in FLOC1. After this number is input, the system will sequence through X-HIGH:, Y-LOW:, and Y-HIGH:. To exit simply type any key that is an illegal answer to the first query.

TFLOC2: Tolerance Feature Locations Side 2

This command allows inputs the same way as for TFLOC1 excepot for Side 2 features.

THLOC1: Tolerance Hole Locations Side 1

This command is exactly the same as TFLOC1 except the first prompt will be HOLE SIDE #1 TOL# and all other inputs are the same as for the features except now they correspond to hole center positions.

SANGAMO WESTON
Schlumberger

THLOC2: Tolerance Hole Locations Side 2

This command is exactly the same as THLOC1 except for Side 2 measurement hole center locations.

TYPE: Type Output Analysis

This command sets all printouts to be operable and the system will answer with PRINTING "ON", and return to the system prompt.

TYPED: Type Distance Data

This command allows distance printing only. The system will respond with PRINTING "ON".

TYPEF: Type Diameter Data

This command allows all diameter measurements to be printed. System will respond with PRINTING "ON".

TYPEH: Type Hole Data

This command allows all hole data locations and diameters to be printed out. The system will respond with PRINTING "ON".

TYPEL: Type Feature Location Data

This command allows selective typing of all feature data. The system will respond with PRINTING "ON".

TYPE 4: Type 4 Diameter Analysis

This command allows all 4 diameter tolerance analysis to be typed. The system will respond with PRINTING "ON".

TYPEN: Type Nothing

TYPEND: Type No Distance Analysis

TYPENF: Type No Diameter Analysis

TYPENH: Type No Hole Analysis

TYPENL: Type No Feature Analysis

TYPEN4: Type No 4 Dia. Analysis

All of the previous commands cause the teletype printouts to be inactive. Their corresponding initializations were previously discussed. The system will respond with PRINTING "OFF".

XY-TABLE: XY-Table Position Input

This command allows the operator to enter the coordinate position, in inches, that the XY-table should be moved to before making any measurements. Simply enter the values as prompted and terminate them with a carriage return. (See DRIVE, ISET and RSET)

ZERO

This command allows the operator to use any point on the XY-table to be a zero or home reference (Ø, Ø). If, however, HOME is issued this reference is set equal to the true home position.

OPERATING AND ROUTINE COMMANDS

;* ATRACE	DO A MANUAL A-TRACE
;* AUTO	AUTOMATIC OPERATION MODE
;* BYPASS	BYPASS INSPECTION
;* CENTER	CENTER BORESIGHT CROSS
;* CLOSE	CLOSE LASER SHUTTER
;* DATA	ANALYZES DATA FORMAT
;* DEBUG	ENTERS EMR TTY DEBUG 1
;* DIST 1	ANALYZE DISTANCES SIDE #1
;* DIST2	ANALYZE DISTANCES SIDE #2
;* DRIVE	DRIVE XY-TABLE TO POSITION
;* FDATA1	FEATURE DATA SIDE #1
;* FDATA2	FEATURE DATA SIDE #2
;* FLOC1	FEATURE LOCATION SIDE #1
;* FLOC2	FEATURE LOCATION SIDE #2
;* FTAG1	FEATURE TAG SIDE #1
;* FTAG2	FEATURE TAG SIDE #2
;* HDATA1	HOLE DIMENSION ANALYSIS SIDE #1
;* HDATA2	HOLE DIMENSION ANALYSIS SIDE #2
;* HIGH#1	SIDE #1 DEPTH CONTROL SWITCH
;* HIGH#2	SIDE #2 DEPTH CONTROL SWITCH
;* HLOC1	ENTER HOLE CENTERS SIDE #1
;* HLOC2	ENTER HOLE CENTERS SIDE #2
;* HOME	HOME XY-TABLE POSITIONING
;* HTAG1	HOLE TAG SIDE #1
;* HTAG2	HOLE TAG SIDE #2
;* INITIAL	INITIAL LOAD POSITION
;* ISET	INITIAL POINT SET
;* LOCATE	LOCATE XY-TABLE POSITION
;* MANUAL	MANUAL OPERATION MODE
;* NORMAL	NORMAL TABLE OPERATION
;* OFFSET	TABLE OFFSET CONTROL
;* OPEN	OPEN LASER SHUTTER
;* PUNCH	PUNCH TRAINING INSTRUCTION
;* RDOS	RDOS (DISK OPERATING SYSTEMS ONLY)
;* READ	READ INPUT TAPES MADE BY PUNCH
;* RESET	RESET TO AUTO MODE
;* RETRACT	RETRACT FOR FLIP/FLOP OF PART
;* RETRAIN	RETRAIN DATUM LINE ANGLES
;* RSET	RETRACT SET
;* RUN	EXECUTE PROGRAM ANALYSIS
;* SCAN	RASTER SCAN (256 x 256)
;* SIDE1	START AT SIDE ONE

SANGAMO WESTON
Schlumberger

;* SIDE2	START AT SIDE TWO
;* STOP!	STOP ALL EXECUTION OF PROGRAM
;* TDIA1	ENTER SIDE #1 DIAMETER TOL'S
;* TDIA2	ENTER SIDE #2 DIAMETER TOL'S
;* T4DIA1	ENTER SIDE #1 4-TOL DIAMETERS
;* T4DIA2	ENTER SIDE #2 4-TOL DIAMETERS
;* THLOC1	ENTER HOLE LOC. TOL'S SIDE #1
;* THLOC2	ENTER HOLE LOC. TOL'S SIDE #2
;* TFLOC1	ENTER FEATURE TOLERANCES SIDE #1
;* TFLOC2	ENTER FEATURE TOLERANCES SIDE #2
;* TYPE	PRINT ALL DATA ANALYSIS
;* TYPED	TYPE DISTANCE DATA
;* TYPEF	TYPE DIAMETER DATA
;* TYPEH	TYPE HOLE DATA
;* TYPEL	TYPE LENGTH DATA ANALYSIS
;* TYPE4	TYPE FOUR DIA'S ANALYSIS
;* TYPEN	TYPE NOTHING
;* TYPEND	TYPE NO DISTANCE ANALYSIS
;* TYPENF	TYPE NO DIAMETER ANALYSIS
;* TYPENH	TYPE NO HOLE ANALYSIS
;* TYPENL	TYPE NO LENGTH ANALYSIS
;* TYPEN4	TYPE NO DIA'S FAILURES
;* XYTABLE	XY-TABLE INPUT
;* ZERO	ZERO CURRENT XY-TABLE REF POINT

929 — Serial 7 Program

TO BY PASS "POINT TOO DARK" MESSAGE.
Change IN F.O. IN LOCATIONS:

LOCATION —	MESSAGE	BY PASS
SIDE1+111 = 13712	6557	401
DEGST+72 = 25771	6727	401
FCEN+ ~~25~~ = ~~751~~ 30306	751	401

LOCATION 404 (end MAX) GIVES Highest LOCATION USE. except Program load routine uses ≈ 50? Locatio at end. — 16K = 37777_8 locations.

THS = 31520	orig. 60	changed to 200	LIMITS theoretical. 0–377

To change correction factor for Hole DIAMETERS:—
USE H.LOC1 TO CONVERT DECIMAL # TO OCTAL #, ie:
Enter 7.15E-5 as XC COORDINATE of Hole #1.
IN DEBUG MODE!
EXAMINE CONTENTS of LOCATION HCX + HCX+1, ie:

HCX = 4453 / Ø36512
H.X+1 = Ø4454 / ~~1452H~~ 174442

OUT of Debug MODE —
Re-ENTER CORRECT DIM. in Hole #1 of H LOC1.

		old	new
IN DEBUG MODE. — FIND Routine for (Hole DIAS.)	COFAX = 16553	Ø36514	036512
	COFAX+1 = 16554	105711	174442
Routine for (4 Hole DIAS)	XFACT = 14610	036463	36512
	XFACT+1 = 14611	034422	174442

D18

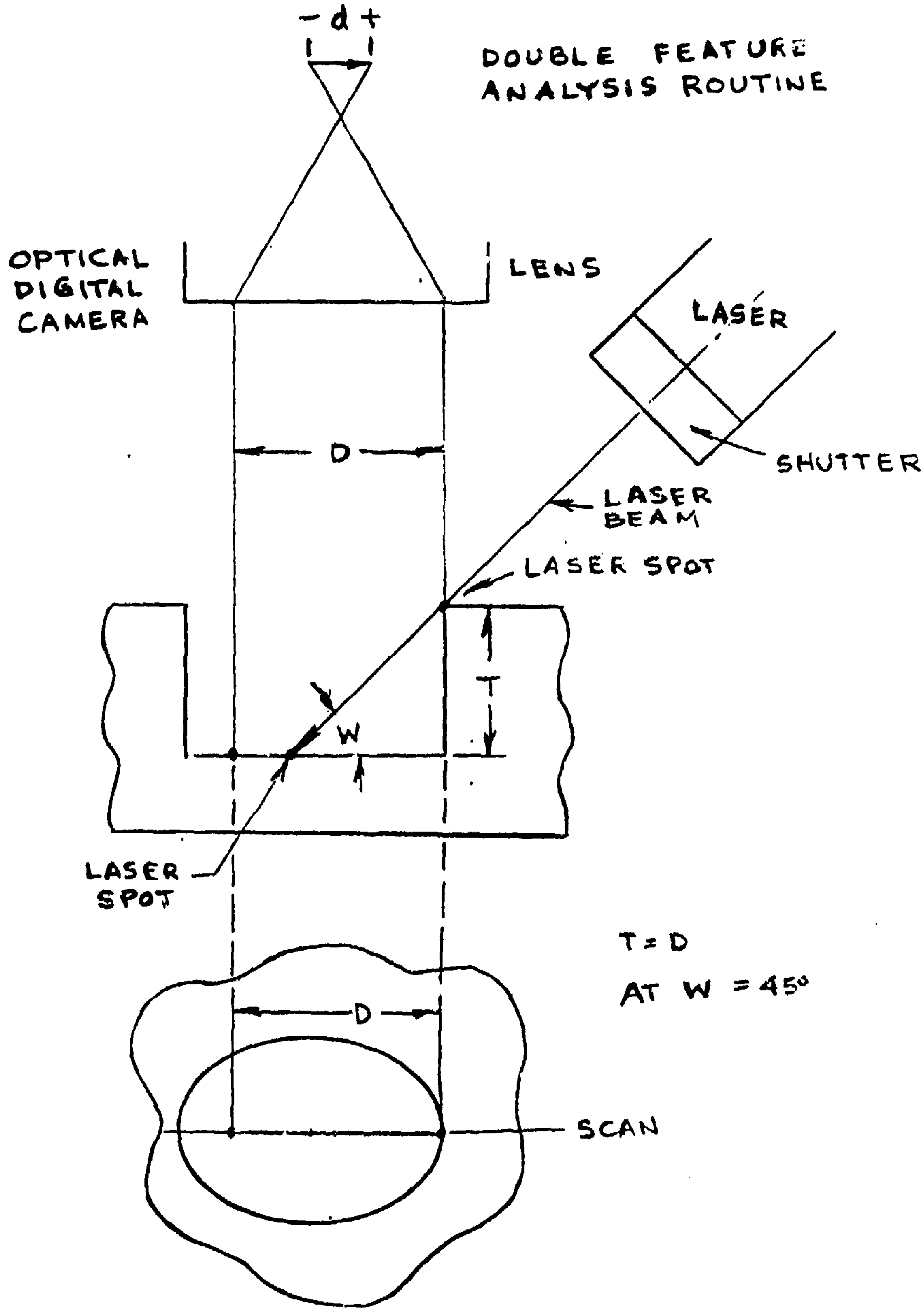
APPENDIX E

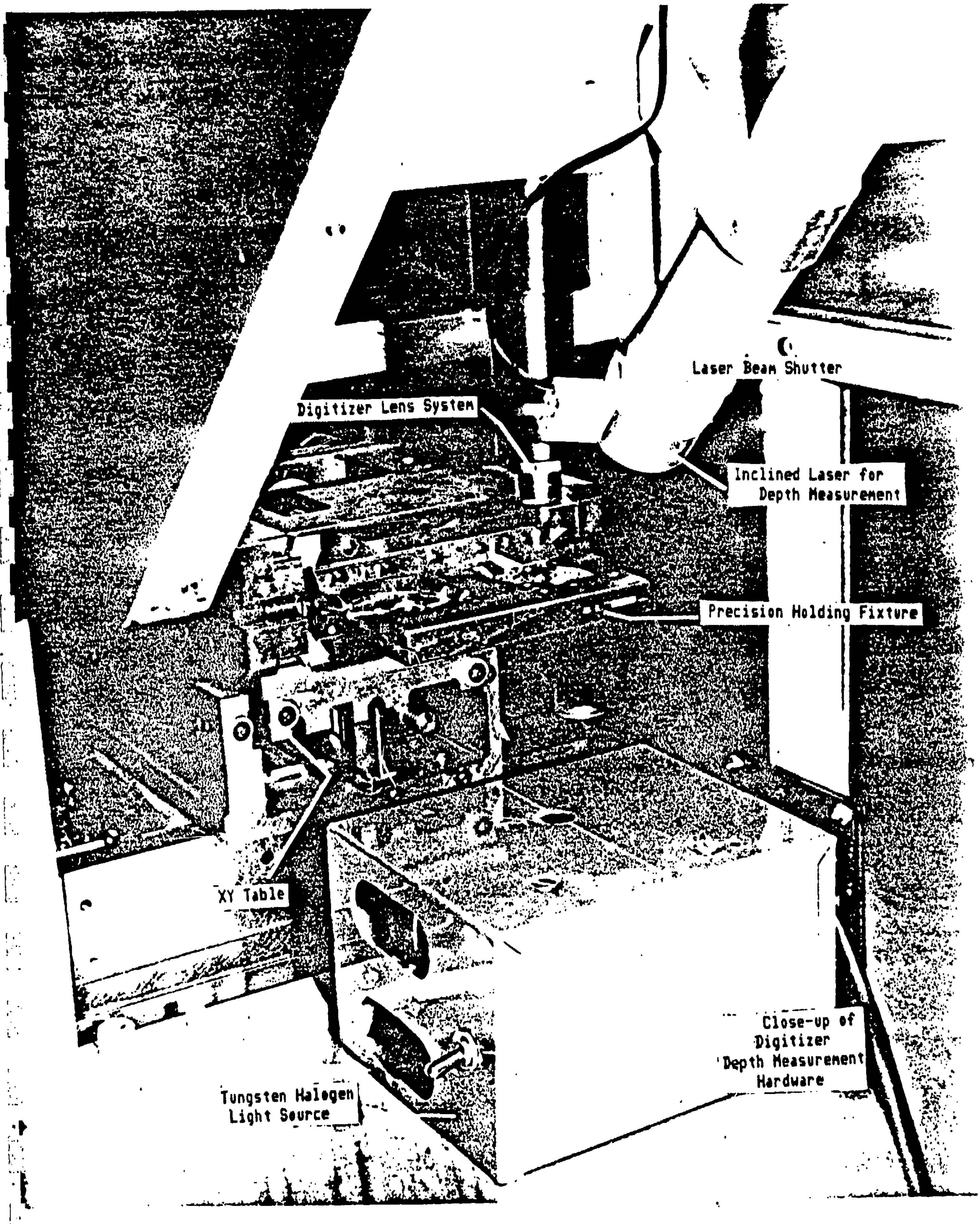
DEPTH HOLE MEASUREMENT

Depth Measurement

A measurement of depth is usually associated with a blind hole or feature where a source of light is unable to pass through the section under observation. Only a reflected source can be used. The technique developed for the Automated Inspection Machine consists of taking a collimated laser beam of light and directing the beam at the edge of the blind hole as feature in such a manner that the beam is split by the edge. One half of the beam is reflected by the top edge and the second half of the beam is reflected by the lower plane of the blind hole or feature. The resultant spots of light are then reviewed by the optical digitizer in a manner similar to that used in the hole measurement routine. A distance is computed which represents the value of the line segment "D" (see Figure Page E3), the horizontal distance between the two split spots of light. If "D" is known and the lazer beam is at an angle of 45 degrees, the value of D is equal to "T" the quantity that represents the thickness or depth. For other angles of the the laser beam, T is no longer equal to D but proportional to D. A simple algorithm would be incorporated into the software to derive T in terms of D and the new angle. Steeper laser beam angles would allow measurement of depths that are larger than the width of the blind hole or feature under observation. For this type measurement, a depth of field of the camera lens system must be sufficiently larger to encompass both spots to prevent error due to optical distortion.

DEPTH MEASUREMENT DIAGRAM




Laser Beam Shutter
Digitizer Lens System
Inclined Laser for Depth Measurement
Precision Holding Fixture
XY Table
Close-up of Digitizer Depth Measurement Hardware
Tungsten Halogen Light Source

APPENDIX F

ACCEPTANCE TEST DATA

INSPECTION REPORT

5. DRAWING No. & REV.	6. W.O.	7. LOT No.	8. SHOP C.C.	9. OPER. No.	10. SHIFT

1. PRODUCT

2. END ITEM

3. PROCEDURE FOR CONTROL OF QUALITY
P.C.O. No. REV. PAGE(S)

4. SAMPLING PLAN (CIRCLE PLAN USED)
MIL-STD. 105, 414, 1235, OTHER ______

11. ☐ ACCEPT ☐ REJECT	SAMPLED MAJOR	MINOR	UNLISTED
(a) AQL / ALLOWED No. DEFECTS			
(b) SAMPLE SIZE			
(c) QUANTITY DEFECTIVE			

12. MARK (X) IF APPLICABLE ☐ SCR 1st SUB. ☐ SCR RESUB.	1st SUB.	RESUB.
(a) QUANTITY SUBMITTED		
(b) QUANTITY ACCEPTED		
(c) QUANTITY REJECTED		

13. REMARKS

14. CD No.	PLATE #		A		PLATE #		B		PLATE #		C	FOR USE BY Q ______		
15. No. PIECES / 16. CHAR. NON-CONFORM.	-X- HOLES LOCATION	Y	HOLE SIZE		X HOLE LOCATION	Y	HOLE SIZE		X HOLE LOCATION	Y	HOLE SIZE			
-A-	DATUM · LOC. .0000	.0000	.0766		.0000	.0000	.0769		.0000	.0000	.0768			
-B-	.7483	1.1990	.0766		.7481	1.1969	.0766		.7481	1.1969	.0769			
-D-	.3742	.5988	.0194		.3742	.5994	.0194		.3736	.5997	.0195			
-N-	.3742	.070	.0995		.3737	.0707	.0992		.3737	.0707	.0993			
8	.2608	.8561	.135		.2585	.8567	.1357		[illegible]	.8565	.1355			
11	.0453	.3232	.1252		.0467	.3242	[illegible]		.0472	[illegible]	.1256			
12	.2288	.7556	.1462		.2308	.7562	[illegible]		[illegible]	[illegible]	.1462			
14	.2837	.6492	.147		.2812	.6482	.1455		[illegible]	.648	.1465			
20	.2664	.4153	.0194		.2668	.4157	.0194		[illegible]	[illegible]	.0195			
22	.2762	.4031	.148		.2785	.4033	.1485		[illegible]	.4033	.148			
26	.7842	.0715	.1508		.781	.070	.1508		[illegible]	[illegible]	.1508			
34	.4647	.5473	.147		.4624	.5476	.146		.463	[illegible]	[illegible]			
35	1.0242	.7932	.148		1.0232	.7926	.148		[illegible]	[illegible]	.148			
45	.8507	1.0587	.151		.848	1.0574	.1515		[illegible]	1.0567	[illegible]			

17. ☐ ALL CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS. ☐ ALL OTHER CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS.

18. PROCESS INSPECTION – C.C., SIGNATURE & DATE ☐ ACCEPT ☐ REJECT
X______

19. PRODUCT INSPECTORS QC., SIGNATURE & DATE ☐ ACCEPT ☐ REJECT
Q______

NCR Paper – DOES NOT REQUIRE CARBON

SHEET ___ OF ___ SHEETS

INSPECTION REPORT

1. PRODUCT
2. END ITEM
3. PROCEDURE FOR CONTROL OF QUALITY P.C.Q. No. REV. PAGE(S)
4. SAMPLING PLAN (CIRCLE PLAN USED) MIL-STD. 105, 414, 1235, OTHER ______

5. DRAWING No. & REV. | 6. W. O. | 7. LOT No. | 8. SHOP C.C. | 9. OPER. No. | 10. SHIFT

11. ☐ ACCEPT ☐ REJECT	SAMPLED MAJOR	MINOR	UNLISTED
(a) AQL / ALLOWED No. DEFECTS			
(b) SAMPLE SIZE			
(c) QUANTITY DEFECTIVE			

12. MARK (X) IF APPLICABLE ☐ SCR 1st SUB. ☐ SCP RESUB.	1st SUB.	RESUB.
(a) QUANTITY SUBMITTED		
(b) QUANTITY ACCEPTED		
(c) QUANTITY REJECTED		

13. REMARKS

14. CD No. / 15. No. PIECES / 16. CHAR. NON-CONFORM.	PLATE # A X HOLE LOCATION	Y	HOLE SIZE		PLATE # B X HOLE LOCATION	Y	HOLE SIZE		PLATE # C X HOLE LOCATION	Y	HOLE SIZE	FOR USE BY Q ______
48	.4447	1.1696	.0976		.445	1.1699	.0977		[illegible]	1.16[illegible]	.0976	
90	.4498	.0587	.0315		.449	.0598	.0312		[illegible]	[illegible]	.0312	
91	.559	.1281	[illegible]		.5558	[illegible]	.025		[illegible]	.1278	.0248	
103	1.0533	.4266	.1134		1.0546	.4268	.1132		1.05[illegible]	[illegible]	.1133	

17. ☐ ALL CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS. ☐ ALL OTHER CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS.

18. PROCESS INSPECTION — CC., SIGNATURE & DATE X______ ☐ ACCEPT ☐ REJECT

19. PRODUCT INSPECTORS QC., SIGNATURE & DATE Q______ ☐ ACCEPT ☐ REJECT

NCR R... . DOES NOT REQUIRE CARBON...

INSPECTION REPORT

5. DRAWING No. & REV.	6. W. O.	7. LOT No.	8. SHOP C.C.	9. OPER. No.	10. SHIFT

SHEET ___ OF ___ SHEETS

1. PRODUCT

2. END ITEM

3. PROCEDURE FOR CONTROL OF QUALITY
P.C.Q. No. REV. PAGE(S)

4. SAMPLING PLAN (CIRCLE PLAN USED)
MIL-STD. 105, 414, 1235, OTHER ______

11. ☐ ACCEPT ☐ REJECT	SAMPLED MAJOR	MINOR	UNLISTED
(a) AQL / ALLOWED No. DEFECTS			
(b) SAMPLE SIZE			
(c) QUANTITY DEFECTIVE			

12. MARK (X) IF APPLICABLE ☐ SCR 1st SUB. ☐ SCP RESUB.	1st SUB.	RESUB.
(a) QUANTITY SUBMITTED		
(b) QUANTITY ACCEPTED		
(c) QUANTITY REJECTED		

13. REMARKS

14. CD No.	PLATE #		D		PLATE #		F		PLATE #		F
15. No. PIECES / 16. CHAR. NON-CONFORM.	X HOLE LOCATION	Y	HOLE SIZE						X HOLE LOCATION	Y	HOLE SIZE
A	.0000	.0000	.0769		.0000	.0000	.0769		.0000	.0000	.0788
B	.748	1.1968	.0769		.748	1.1969	.0768		.748	1.1968	.0789
O	.3138	.600	.194		.374	.5987	.0193		.3733	.5993	.0195
N	.3743	.0702	.0995		.3742	.0712	.0993		.3741	.071	.0993
8	.2599	.8578	.1355		.2599	.8579	.1367		.2596	.8574	.1355
11	.0463	.3243	.1254		.0458	.322	.1255		.0461	.3248	.1255
12	.2304	.7565	.1462		.2292	.7572	.146		.2298	.7568	.1461
14	.281	.649	.1458		.282	.6478	.1465		.282	.6482	.146
20	.2666	.4161	.0191		.2655	.4156	.0195		.266	.4156	.0194
22	.2787	.404	.1478		.2774	.4048	.1485		.2776	.4042	.148
26	.7816	.071	.1508		.7818	.0699	.1509		.7814	.0703	.1508
34	.4644	.5484	.145		.463	.5479	.1452		.465	.5474	.1458
35	1.0238	.7925	.1479		1.0242	.792	.148		[illegible]	.7922	.1485
45	.8479	1.0582	.1508		.850	1.0574	.1508		.848	1.0581	.1508

FOR USE BY Q ______

17. ☐ ALL CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS. ☐ ALL OTHER CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS.

18. PROCESS INSPECTION — CC., SIGNATURE & DATE X______ ☐ ACCEPT ☐ REJECT

19. PRODUCT INSPECTORS QC., SIGNATURE & DATE Q______ ☐ ACCEPT ☐ REJECT

SARPA-AT Form 79, 29 Mar 74

NCR Paper — — DOES NOT REQUIRE CARBONS

INSPECTION REPORT

5. DRAWING No. & REV.	6. W. O.	7. LOT No.	8. SHOP C.C. / 9. OPER. No. / 10. SHIFT

1. PRODUCT

2. END ITEM

3. PROCEDURE FOR CONTROL OF QUALITY
P.C.O. No. REV. PAGE(S)

4. SAMPLING PLAN (CIRCLE PLAN USED)
MIL-STD. 105, 414, 1235, OTHER ______

11. ☐ ACCEPT ☐ REJECT	SAMPLED MAJOR	MINOR	UNLISTED
(a) AQL / ALLOWED No. DEFECTS			
(b) SAMPLE SIZE			
(c) QUANTITY DEFECTIVE			

12. MARK (X) IF APPLICABLE ☐ SCR 1st SUB. ☐ SCR RESUB.	1st SUB.	RESUB.
(a) QUANTITY SUBMITTED		
(b) QUANTITY ACCEPTED		
(c) QUANTITY REJECTED		

13. REMARKS

FOR USE BY Q ______

14. C D No. / 15. No. PIECES / 16. CHAR. NON-CONFM.	PLATE # [illegible] X HOLE LOCATION	Y	HOLE SIZE		PLATE # E X HOLE LOCATION	Y	HOLE SIZE		PLATE # [illegible] X HOLE LOCATION	Y	HOLE SIZE
47	.445	1.17[illegible]	.0[illegible]		.4448	1.1694	[illegible]		[illegible]	[illegible]	.1[illegible]
90	.4492	.06[illegible]	[illegible]		.449	.0691	.0[illegible]4		[illegible]	.0606	.[illegible]314
91	.5575	.1297	[illegible]52		.5578	.1294	.0244		[illegible]	.1277	.0[illegible]
103	1.0549	.4272	.1137		1.0546	.4764	.11[illegible]		1.0[illegible]	[illegible]	.11[illegible]2

17. ☐ ALL CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS. ☐ ALL OTHER CHAR. IN SAMPLE COMPLY WITH DWG. REQMTS.

18. PROCESS INSPECTION – CC., SIGNATURE & DATE ☐ ACCEPT ☐ REJECT
X______

19. PRODUCT INSPECTORS QC., SIGNATURE & DATE ☐ ACCEPT ☐ REJECT
Q______

NCR P[illegible] DOES NOT REQUIRE CARBON

INSPECTION REPORT

SMUFA-X Form 39, 20 Apr 66
(Formerly SMUFA Form C3083)

1. TO:

2. FROM:

3. NOMENCLATURE: PLATE #1 FIRST LAMINA.

4. DRAWING NO. & REV.: 105-42821

5. SAMPLED	MAJOR	MINOR
a. A.Q.L.		
b. SAMPLE SIZE	100%	
c. QTY. DEFECTIVE		

6. TOTAL	
a. QTY. SUBMITTED	6
b. QTY. ACCEPTED	
c. QTY. DEFECTIVE	

7. WORK ORDER:

8. END ITEM: FUZE

9. LOT NO.

10. TYPE OF INSP: 100%

11. SHOP X3140

12. OPERATION NO:

CHARACTERISTICS INSPECTED

13. PC. NO. / 14. CHAR.	TH'K .0961 -.0016	SECTION F-F .0576 -.002 A	F-F .0576 -.002 D	F-F .0556 -.006 B	F-F .0556 -.006 C	SECTION C-C .069+ .0015	DETAIL K .031 -.002	SIZE OF SLOT .250 +.001	.583 -.006	SIZE OF T SLOT .1504 +.0008	.0404 +.0008	.0784 +.0008	.2745 BASIC
A	.0948 .0955	.056	.055	.054	.054	.065	.030	.2506	.582	.150	.040	.0987	.275
B	.0948 .0955	.056	.054	.053	.052	.065	.030	.2498	.582	.151	.040	.0986	.275
C	.0948 .0957	.055	.056	.053	.055	.067	.030	.2503	.581	.150	.040	.0987	.274
D	.0945 .0953	.056	.056	.053	.054	.066	.029	.2498	.582	.150	.040	.0987	.273
E	.0950 .0955	.055	.055	.052	.052	.070	.030	.2507	.582	.150	.040	.0987	.275
F	.0945 .0955	.056	.054	.055	.054	.067	.031	.2506	.581	.150	.040	.0987	.274

15. DATE: 4-30-76

16. INSPECTOR'S NO: 195-12-1609

17. INSPECTOR'S SIGNATURE: [signature]

SHEET OF SHEETS

INSPECTION REPORT

SMUFA-X Form 39, 20 Apr 66
(Formerly SMUFA Form C3083)

3. NOMENCLATURE: PLATE # 1 FIRST LAMINA		4. DRAWING NO. & REV.: 10542871
5. SAMPLED — MAJOR / MINOR	6. TOTAL	7. WORK ORDER:
a. A.Q.L. 100%	a. QTY. SUBMITTED 6	8. END ITEM:
b. SAMPLE SIZE	b. QTY. ACCEPTED	9. LOT NO. / 10. TYPE OF INSP: 100%
c. QTY. DEFECTIVE	c. QTY. DEFECTIVE	11. SHOP X3140 / 12. OPERATION NO:

1. TO:

2. FROM:

CHARACTERISTICS INSPECTED

14. SECTION F.F

13. PC. NO. \ CHAR.	.154 ±.004 Both Slots	.046 ±.002 Both Slots	.448 ±.001 Both Ends
A	.155	.053	.447
B	.155	.053	.447
C	.155	.0528	.448
D	.155	.053	.447
E	.155	.053	.447
F	.155	.0528	.448

15. DATE:

16. INSPECTOR'S NO:

17. INSPECTOR'S SIGNATURE:

PLATE NO.1
FIRST LAYING
F-10540801
DATE 4/9/76

PART A

		+TOL.	-TOL.		NOM.		ACT.	O.T.
LOCA	X	+.0010	+.0000	+	.0001	-	.0013	-.0010
	Y	+.0010	+.0000	+	.0000	+	.0000	
LOCB	X	+.0013	-.0013	-	.7480	-	.7471	
	Y	+.0013	-.0013	+	1.1968	+	1.1989	+.0011
LOCD	X	+.0012	-.0012	-	.3740	-	.3736	
	Y	+.0012	-.0012	+	.5984	+	.5994	
LOCN	X	+.0012	-.0012	-	.3740	-	.3733	
	Y	+.0012	-.0012	-	.0700	-	.0693	
HOL8	X	+.0095	-.0095	-	.2604	-	.2570	
	Y	+.0095	-.0095	+	.8565	+	.8580	
HL11	X	+.0085	-.0085	+	.0453	+	.0466	
	Y	+.0085	-.0085	+	.3000	+	.3034	
HL12	X	+.0056	-.0056	+	.2285	+	.2294	-.0004
	Y	+.0056	-.0056	+	.7559	+	.7562	
HL14	X	+.0056	-.0056	-	.2835	-	.2816	
	Y	+.0056	-.0056	+	.6494	+	.6485	
HL20	X	+.0000	+.0000	-	.2661	-	.2650	+.0011
	Y	+.0000	+.0000	+	.4153	+	.4160	+.0007
HL22	X	+.0040	-.0040	+	.2763	+	.2755	
	Y	+.0040	-.0040	+	.4034	+	.4030	
HL26	X	+.0040	-.0040	-	.7843	-	.7818	
	Y	+.0040	-.0040	+	.0717	+	.0731	
HL34	X	+.0056	-.0056	-	.4645	-	.4638	
	Y	+.0056	-.0056	+	.5474	+	.5470	
HL35	X	+.0040	-.0040	-	1.0240	-	1.0230	
	Y	+.0040	-.0040	+	.7934	+	.7929	
HL45	X	+.0040	-.0040	-	.8535	-	.8476	
	Y	+.0040	-.0040	+	1.0589	+	1.0574	
HL48	X	+.0040	-.0040	-	.4450	-	.4438	
	Y	+.0040	-.0040	+	1.1694	+	1.1685	
HL90	X	+.0060	-.0060	+	.4522	-	.4490	
	Y	+.0060	-.0060	+	.0613	+	.0584	
HL91	X	+.0060	-.0060	-	.5610	-	.5585	
	Y	+.0060	-.0060	+	[illegible]	+	[illegible]	

```
H103  X +.0000 -.0000 - 1.0540 - 1.0540
      Y +.0000 -.0000 +  .4264 +  .4200

      DIMENSIONAL C/L   CENTER LINE  HOLE 20
CL20  X +.0000 -.0000 +  .2125 +  .2130 +.0005
      Y +.0000 +.0000 +  .0000 +  .0001 +.0001

      SECT. C-C
DPCR  Y +.0000 +.0000 +  .0000 +  .0378 +.0378
      Y +.0000 +.0000 +  .0000 +  .3102 +.3102
      Z +.0015 +.0001 +  .0690 +  .0600

[redacted]
LOS1  X +.0000 +.0000 +  .0000 -  .0001 -.0001
      Y +.0010 -.0010 -  .4480 -  .4470

LSL1  X +.0000 +.0000 +  .0000 -  .0004 -.0004
      Y +.0340 -.0340 +  .1540 +  .1546

LOS2  X +.0000 +.0000 +  .0000 -  .0000 -.0000
      Y +.0010 -.0010 +  .4480 +  .4488

LSL2  Y +.0000 +.0000 +  .0000 -  .0005 -.0005
      Y +.0040 -.0040 -  .1540 -  .1550

LOS3  X +.0000 -.0000 +  .2745 +  .2763 +.[redacted]
      Y +.0000 +.0000 +  .0000 +  .0001 +.0001

LOS3  Y +.0040 -.0040 -  .5510 +  .5545 +1.101
      Y +.0000 +.0000 +  .0000 -  .0015 -.

LOS4  Y +.0000 -.0060 +  .5800 +  .5792
      Y +.0000 +.0000 +  .0000 -  .0009 -.0009

      CENTER VIEW
DIAP  X +.0000 -.0012 + 1.6120 + 1.6115
      Y +.0000 +.0000 +  .0000 -  .0001 -.0001

DIAP  X +.0000 +.0000 +  .0000 -  .0001 -.0001
      Y +.0000 -.0012 + 1.6120 + 1.6101 -.0007

THPL  X +.0000 +.0000 +  .0000 -14.2808 -14.28
      Y +.0000 +.0000 +  .0000 -  .2969 -.2969
      Z +.0000 -.0016 +  .0961 +  .0961

      SEC. F-F
DEPA  ~~X +.0000 +.0000 +  .0000 -14.5145 -14.51~~
      ~~Y +.0000 +.0000 +  .0000 -  .1000 -.1000~~
      Z +.0000 -.0020 +  .0576 +  .0549 -.0007

DEPB  ~~X +.0000 +.0000 +  .0000 -14.7000 -14.70~~
      ~~Y +.0000 +.0000 +  .0000 -  .4672 -.4672~~
      Z +.0000 -.0060 +  .0556 +  .0534

DEPC  ~~X +.0000 +.0000 +  .0000 -14.7312 -14.73~~
      ~~Y +.0000 +.0000 +  .0000 - 1.1341 -1.134~~
      Z +.0000 -.0060 +  .0556 +  .0535

DEPD  ~~X +.0000 +.0000 +  .0000 -14.7499 -14.74~~
      ~~Y +.0000 +.0000 +  .0000 - 1.4825 -1.482~~
      Z +.0000 -.0020 +  .0576 +  .0548 -.0008
```

PART B

PART B

PLATE NO.1
FIRST L[illegible]
F-1[illegible]
DATE 4/12/76

		+TOL.	-TOL.		NOM.		ACT.	D.T.
L00[illegible]	X	[illegible]	[illegible]	+	[illegible]	+	[illegible]	
	Y	[illegible]	[illegible]	+	[illegible]	+	[illegible]	
L00[illegible]	X	[illegible]	[illegible]	-	.748[illegible]	-	.7478	
	Y	[illegible]	[illegible]	+	1.19[illegible]	+	1.1977	
L00[illegible]	X	+.0012	-.0012	-	.3743	-	.3743	
	Y	+.0012	-.0012	+	.5974	+	[illegible]	
L00[illegible]	X	+.0012	-.0012	-	.374[illegible]	-	.3739	
	Y	+.0012	-.0012	-	.37[illegible]	-	.3717	
HOL9	X	+.0085	-.0085	-	.25[illegible]	-	.2565	
	Y	+.0085	-.0085	+	.2565	+	.2554	
HL11	X	+.0025	-.0025	+	.0453	+	.0475	
	Y	+.0025	-.0025	+	.3229	+	.3227	
HL12	X	+.0056	-.0056	+	.2285	+	.2290	
	Y	+.0056	-.0056	+	.7559	+	.7553	
HL14	X	+.0056	-.0056	-	.2835	-	.2809	
	Y	+.0056	-.0056	+	.6424	+	.6478	
HL22	X	+.0000	+.0000	-	.2661	-	.2664	-.0003
	Y	+.0000	+.0000	+	.4153	+	.4152	-.0003
HL29	X	+.0040	-.0040	+	.2763	+	.2767	
	Y	+.0040	-.0040	+	.4234	+	.4232	
HL26	X	+.0040	-.0040	-	.7840	-	.7813	
	Y	+.0040	-.0040	+	.3717	+	.3713	
HL34	X	+.0056	-.0056	-	.4645	-	.463[illegible]	
	Y	+.0056	-.0056	+	.5474	+	.5475	
HL35	X	+.0040	-.0040	-	1.0240	-	1.0235	
	Y	+.0040	-.0040	+	.7934	+	.7935	
HL45	X	+.0040	-.0040	-	.8515	-	.8482	
	Y	+.0040	-.0040	+	1.0589	+	1.0590	
HL48	X	+.0040	-.0040	-	.4450	-	.4439	
	Y	+.0040	-.0040	+	1.1694	+	1.1703	
HL90	X	+.0060	-.0060	-	.4522	-	.4470	
	Y	+.0060	-.0060	+	.0613	+	.0597	
HL91	X	+.0060	-.0060	-	.5610	-	.5561	
	Y	+.0060	-.0060	+	.1311	+	.1296	

```
H103   X +.0000 -.0000 - 1.0540 - 1.0540
       Y +.0000 -.0000 + .0042 +  .0070

       DIMENSIONAL C/L   CENTER LINE  HOLE 30
CL00   X +.0000 -.0000 +  .0125 +  .0121 +.0000
       Y +.0000 +.0000 +  .0000 +  .0001 +.0001

       SECT. C-C
DPC0   X +.0000 +.0000 +  .0000 +  .2460 +.2460
       Y +.0000 +.0000 +  .0000 +  .2799 +.2729
       Z +.0015 +.0000 +  .0690 +  .0695

[redacted]    [redacted]
LOS1   X +.0000 +.0000 +  .0000 +  .0000
       Y +.0010 -.0010 -  .4480 -  .4460 +.0010

LSL1   X +.0000 +.0000 +  .0000 +  .0000
       Y +.0040 -.0040 +  .1540 +  .1581 +.0001

LOS2   X +.0000 +.0000 +  .0000 +  .0200
       Y +.0010 -.0010 +  .4490 +  .4480

LSL2   X +.0000 +.0000 +  .0000 +  .0001 +.0001
       Y +.0040 -.0040 -  .1540 -  .1569

LOS3   X +.0020 -.0020 +  .2745 +  .2746
       Y +.0000C.0000 +  .0000 +  .0000

LOS3   X +.0040 -.0040 -  .5500 -  .5500
       Y +.0000 +.0000 +  .0000 + 0000 C.0000

LOS4   X +.0000 -.0060 +  .5800 +  .5822
       Y +.0000 +.0000 +  .0000 -  .0001 -.0001

       CENTER VIEW
DIAP   X +.0000 -.0012 + 1.6120 + 1.6103 -.0005
       Y +.0000 +.0000# .0000  .0000 -.0001

DIAP   X +.0000 +.0000 +  .0000 +  .0001 +.0001
       Y +.0000 -.0012 + 1.6123 + 1.6075 -.0033

THPL   X +.0000 +.0000 +  .0000 - 9.4441 -9.444
       Y +.0000 0000 +  .0000- 1.5675 -1.567
       Z +.0000 -.0016 +  .0961 +  .0968 +.0007

       SEC. F-F
DEPA   X +.0000 +.0000 +  0000 - 8.6361 -8.636
       Y +.0000 +.0000X  .0000 - 1.2285 -1.228
       Z +.0000 -.0020 +  .0576 +  .0553 -.0003

DEPB   X +.0000 +.0000    .0000 - 8.9592 -8.959
       Y +.0000 +.0000C  .0000 - 1.5339 -1.533
       +Z  ~~+.0000~~ - .006  .0556  .0582

DEPC   X +.0000 +.0000 +  .0000 +  .2809 +.2809
       Y +.0000 +.0000 +  .0000 - 2.1747 -2.174
       Z +.0000 -.0060 +  .0556 +  .0591

DEPD   X +.0000 +.0000 +  .0000 +  .0917 +.0917
       Y +.0000 +.0000 +  .0000 - 2.4418 -2.441
       Z +.0000 -.0020 +  .0576 +  .0529 -.0027
```

PLATE NO.1
FIRST LAMINA
F-17542221
DATE 4/14/76

PART C

		+TOL.	-TOL.		NOM.		ACT.	O.T.
LOCA	X	+.0000	+.0000	+	.0000	-	.0030	-.0030
	Y	+.0000	+.0000	+	.0000	-	.0000	-.0000
LOCB	X	+.0010	-.0010	-	.7480	-	.7482	
	Y	+.0010	-.0010	+	1.1968	+	1.1977	
LOCD	X	+.0012	-.0012	-	.3740	-	.3741	
	Y	+.0012	-.0012	+	.5984	+	.5990	
LOCN	X	+.0012	-.0012	-	.3740	-	.3737	
	Y	+.0012	-.0012	-	.0739	-	.3710	
HOLB	X	+.0085	-.0085	-	.2604	-	.2588	
	Y	+.0085	-.0085	+	.8565	+	.8571	
HL11	X	+.0085	-.0085	+	.0450	+	.0466	
	Y	+.0085	-.0085	+	.3229	+	.3234	
HL12	X	+.0056	-.0056	+	.2285	+	.2281	
	Y	+.0056	-.0056	+	.7559	+	.7559	
HL14	X	+.0056	-.0056	-	.2835	-	.2826	
	Y	+.0056	-.0056	+	.6494	+	.6472	
HL20	X	+.0000	+.0000	-	.2661	-	.2662	-.0001
	Y	+.0000	+.0000	+	.4153	+	.4157	+.0004
HL22	X	+.0040	-.0040	+	.2760	+	.2772	
	Y	+.0040	-.0040	+	.4034	+	.4025	
HL26	X	+.0040	-.0040	-	.7840	-	.7819	
	Y	+.0040	-.0040	+	.0717	+	.0707	
HL34	X	+.0056	-.0056	-	.4645	-	.4633	
	Y	+.0056	-.0056	+	.5474	+	.5468	
HL35	X	+.0040	-.0040	-	1.0240	-	1.0242	
	Y	+.0040	-.0040	+	.7934	+	.7923	
HL45	X	+.0040	-.0040	-	.8505	-	.8490	
	Y	+.0040	-.0040	+	1.0589	+	1.0577	
HL48	X	+.0040	-.0040	-	.4450	-	.4452	
	Y	+.0040	-.0040	+	1.1694	+	1.1703	
HL90	X	+.0060	-.0060	-	.4522	-	.4470	
	Y	+.0060	-.0060	+	.0613	+	.0581	
HL91	X	+.0060	-.0060	-	.5610	-	.5574	
	Y	+.0060	-.0060	+	.1311	+	.1279	

```
H133  Y +.3333 -.3333 - 1.3541 - 1.3542
      Y +.3333 -.3330 +  .4264 +  .4272

      DIMENSIONAL C/L   CENTER LINE  HOLE 24
CL22  X +.3333 -.3333 +  .2125 +  .2131 +.3333
      Y +.3333 +.3330 ++  .3330 +  .3331 +.3331
      SECT. C-C
DPCA  X +.3333 +.3333 +  .3330 +  .3822 +.3822
      Y +.3330 +.3333 +  .3333 + 1.3034 +1.303
      Z +.3315 +.3330 +  .3690 + -.3690 -.3303

[redacted]
LOS1  Y +.3330 +.3333 +  .3333 +  .3303
      Y +.3310 -.0319 -  .4490 -  .4454 +.3316

LSL1  Y +.3333 +.3330 +  .3330 -  .3333 -.3330
      Y +.3340 -.3340 +  .1540 +  .1563

LOS2  Y +.3333 +.3330 +  .3303 +  .3169 +.3169
      Y +.3310 -.3310 +  .4490 +  .4478

LSL2  Y +.3333 +.3333 +  .3333 -  .3301 -.3331
      Y +.3340 -.3340 -  .1540 -  .1574

LOS3  X +.3323 -.3323 +  .2745 +  .2747 -[redacted]
      Y +.3331 +.3331 +  .3331 +  .3331 +.3331

LOS3  Y +.3340 -.3340 -  .5519 -  .5536
      Y +.3330 +.3333 +  .3333 +  .3331 +.3331

LOS4  X +.3332 -.3360 +  .5830 +  .5815
      Y +.3333 +.3331 +  .3330 -  .3333 -.3333

      CENTER VIEW
DIAP  X +.3310 -.3312 + 1.6124 + 1.6110
      Y +.3333 +.0003 +  .3303 +  .0331 +.3331

DIAP  Y +.3333 +.3333 +  .3333 -  .3301 -.3301
      Y +.3330 -.3312 + 1.6120 + 1.6087 -.0021

THPL  X +.3333 +.3332 +  .0000 - 9.1431 -9.143
      Y +.3303 +.3330 +  .3033 - 1.3358 -1.335
      Z +.3303 -.3316 +  .3961 +  .3953

      SEC. F-F
DEPA  X +.3333 +.3330 +  .3333 - 9.3594 -9.359
      Y +.3333 +.3333 +  .3331 -  .5361 -.5361
      Z +.3333 -.3323 +  .0576 +  .0543 -.0013

DEPB  Y +.3333 +.3333 +  .3330 - 9.6233 -9.623
      Y +.3333 +.3330 +  .0000 -  .7834 -.7834
      Z +.3303 -.0360 +  .0556 +  .0520

DEPC  Y +.3330 +.3333 +  .3333 - 9.9634 -9.963
      Y +.3033 +.3330 +  .0030 - 1.3730 -1.373
      Z +.3330 -.0360 +  .0556 +  .0532

DEPD  Y +.3333 +.3000 +  .0000 -10.0939 -10.09
      Y +.3333 +.3300 +  .3333 - 1.6333 -1.633
      Z +.0300 -.0320 +  .0576 +  .0547 -.3302
```

PLATE NO.1
FIRST LAYING
[illegible]
DATE 4/14/76

PART D

		+TOL.	-TOL.		NOM.		ACT.	O.T.
L0CA	X	+.0000	+.0000	+	.0002	-	.0200	-.0000
	Y	+.0000	+.0000	+	.0000	-	.0002	-.0000
L0CB	X	+.0012	-.0012	-	.7480	-	.7472	
	Y	+.0012	-.0010	+	1.1968	+	1.1993	+.0005
L0CD	X	+.0012	-.0012	-	.3740	-	.3733	
	Y	+.0012	-.0012	+	.5984	+	.5994	
L0CN	X	+.0012	-.0012	-	.3740	-	.3736	
	Y	+.0012	-.0012	-	.0709	-	.0731	
HOL8	X	+.0085	-.0085	-	.2604	-	.2585	
	Y	+.0085	-.0085	+	.8565	+	.859[illegible]	
HL11	X	+.0085	-.0085	+	.0450	+	.0463	
	Y	+.0085	-.0085	+	.3229	+	.3245	
HL12	X	+.0056	-.0056	+	.2285	+	.2305	
	Y	+.0056	-.0056	+	.7559	+	.7561	
HL14	X	+.0056	-.0056	-	.2835	-	.2805	
	Y	+.0056	-.0056	+	.6494	+	.6488	
HL20	X	+.0000	+.0000	-	.2661	-	.2660	+.0001
	Y	+.0000	+.0000	+	.4153	+	.4151	-.0002
HL22	X	+.0040	-.0040	+	.2760	+	.2787	
	Y	+.0040	-.0040	+	.4034	+	.4016	
HL26	X	+.0040	-.0040	-	.7840	-	.7832	
	Y	+.0040	-.0040	+	.0717	+	.0709	
HL34	X	+.0056	-.0056	-	.4645	-	.4614	
	Y	+.0056	-.0056	+	.5474	+	.5460	
HL35	X	+.0040	-.0040	-	1.0240	-	1.0207	
	Y	+.0040	-.0040	+	.7934	+	.7924	
HL45	X	+.0040	-.0040	-	.8505	-	.8450	+.0015
	Y	+.0040	-.0040	+	1.0589	+	1.0576	
HL48	X	+.0040	-.0040	-	.4450	-	.4433	
	Y	+.0040	-.0040	+	1.1694	+	1.1710	
HL90	X	+.0060	-.0060	-	.4522	-	.4470	
	Y	+.0060	-.0060	+	.0613	+	.0604	
HL91	X	+.0060	-.0060	-	.5610	-	.5568	
	Y	+.0060	-.0060	+	.1311	+	.1306	
H103	X	+.0030	-.0030	-	1.0540	-	1.0548	
	Y	+.0030	-.0030	+	.4264	+	.4285	

```
        DIMENSIONAL C/L   CENTER LINE  HOLE 20
CL2?    X +.0003 -.0073 +  .2125 +  .2125
        Y +.0000 +.0000 +  .0002 +  .0002

        SECT. C-C
DPCR    X +.0000 +.0000 +  .0000 +  .1794 +.1794
        Y +.0000 +.0000 +  .0000 +  .3112 +.3112
        Z +.0015 +.0000 +  .0692 +  .0692

[redacted]
LOS1    X +.0000 +.0000 +  .0000 +  .0002 +.0002
        Y +.0010 -.0010 -  .4450 -  .4451 +.0019

LSL1    X +.0000 +.0000 +  .0000 +  .0004 +.0004
        Y +.0040 -.0040 +  .1540 +  .1584 +.0004

LOS2    X +.0000 +.0000 +  .0000 +  .0000
        Y +.0010 -.0010 +  .4450 +  .4485

LSL2    X +.0003 +.0000 +  .0000 +  .0002 +.0002
        Y +.0040 -.0040 -  .1540 -  .1594 -.0014

LOS3    X +.0020 -.0020 +  .2745 +  .2745
        Y +.0000 +.0000 +  .0000 -  .0000 -.0000

LOS3    X +.0040 -.0040 -  .5510 -  .5536
        Y +.0000 +.0000 +  .0000 +  .0007 +.0007

LOS4    X +.0000 -.0060 +  .5930 +  .5804
        Y +.0000 +.0000 +  .0000 +  .0001 +.0001

        CENTER VIEW
DIAP    X +.0000 -.0012 + 1.6120 + 1.6115
        Y +.0000 +.0000 +  .0000 -  .0000 -.0000

DIAP    X +.0000 +.0000 +  .0000 +  .0001 +.0001
        Y +.0000 -.0012 + 1.6120 + 1.6079 -.0029

THPL    X +.0000 +.0000 +  .0000 - 8.8220 -8.822
        Y +.0000 +.0000 +  .0000 - 2.0117 -2.011
        Z +.0000 -.0016 +  .0961 +  .0956

        SEC. F-F
DEPA    X +.0000 +.0000 +  .0000 - 8.7324 -8.732
        Y +.0000 +.0000 +  .0000 - 1.2028 -1.202
        Z +.0000 -.0020 +  .0576 +  .0542 -.0014

DEPB    X +.0000 +.0000 +  .0000 - 8.8533 -8.853
        Y +.0000 +.0000 +  .0000 - 1.4384 -1.438
        Z +.0000 -.0060 +  .0556 +  .0523

DEPC    X +.0000 +.0000 +  .0000 - 9.1121 -9.112
        Y +.0000 +.0000 +  .0000 - 2.1721 -2.172
        Z +.0000 -.0060 +  .0556 +  .0524

DEPD    X +.0000 +.0000 +  .0000 - 9.1586 -9.158
        Y +.0000 +.0000 +  .0000 - 2.4607 -2.460
        Z +.0000 -.0020 +  .0576 +  .0545 -.0011
```

PART E

```
PLATE NO.1
FIRST LAMINA
F-12540001
DATE 4/15/76
              +TOL.    -TOL.      NOM.      ACT.     O.T.
LOCA  X [illegible]
      Y [illegible]

LOCB  X +.0010 -.0010 -   .7480 -  .7474
      Y +.0010 -.0010 + 1.1968 + 1.1975 +.0007

LOCD  X +.0012 -.0012 -   .3740 -   .3742
      Y +.0012 -.0012 +   .5984 +   .5995

LOCN  X +.0012 -.0012 -   .3740 -   .3740
      Y +.0012 -.0012 -   .3709 -   .3696 +.0001

HOL8  X +.0085 -.0085 -   .2634 -   .2636
      Y +.0085 -.0085 +   .8565 +   .8594

HL11  X +.0085 -.0085 +   .0450 +   .0445
      Y +.0085 -.0085 +   .3229 +   .3228

HL12  X +.0056 -.0056 +   .2285 +   .2277
      Y +.0056 -.0056 +   .7559 +   .7591

HL14  X +.0056 -.0056 -   .2835 -   .2840
      Y +.0056 -.0056 +   .6494 +   .6505

HL20  X +.0000 +.0000 -   .2661 -   .2662 -.0001
      Y +.0000 +.0000 +   .4153 +   .4156 +.0003

HL22  X +.0040 -.0040 +   .2760 +   .2782
      Y +.0040 -.0040 +   .4034 +   .4059

HL26  X +.0040 -.0040 -   .7840 -   .7795 +.0005
      Y +.0040 -.0040 +   .0717 +   .0723

HL34  X +.0056 -.0056 -   .4645 -   .4614
      Y +.0056 -.0056 +   .5474 +   .5484

HL35  X +.0040 -.0040 - 1.0240 - 1.0240
      Y +.0040 -.0040 +   .7934 +   .7930

HL45  X +.0040 -.0040 -   .8505 -   .8500
      Y +.0040 -.0040 + 1.0589 + 1.0582

HL48  X +.0040 +.0040 =   .4450 -   .4443
      Y +.0040 -.0040 + 1.1694 + 1.1706

HL90  X +.0060 -.0060 -   .4522 -   .4479
      Y +.0060 -.0060 +   .0613 +   .0599

HL91  X +.0060 -.0060 -   .5610 -   .5569
      Y +.0060 -.0060 +   .1311 +   .1305

H103  X +.0030 -.0030 - 1.0540 - 1.0541
      Y +.0030 -.0030 +   .4264 +   .4285
```

DIMENSIONAL C/L CENTER LINE HOLE 20

CLP?	X	+.0000	-.0000	+	.2125	+	.2134	+.0016
	Y	+.0000	+.0000	+	.0000	-	.0001	-.0001

SECT. C-C

DPCP	X	+.0000	+.0000	+	.0000	+	.2952	+.2952
	Y	+.0000	+.0000	+	.0000	+	.2848	+.2848
	Z	+.0015	+.0000	+	.0690	+	.0710	+.0005

[redacted]

LOS1	X	+.0000	+.0000	+	.0000	+	.0714	+.0714
	Y	+.0010	-.0010	-	.4480	-	.4455	+.0015
LSL1	X	+.0000	+.0000	+	.0000	-	.0002	-.0002
	Y	+.0040	-.0040	+	.1540	+	.1575	
LOS2	X	+.0000	+.0000	+	.0000	+	.0010	
	Y	+.0010	-.0010	+	.4480	+	.4466	-.0004
LSL2	X	+.0000	+.0000	+	.0000	-	.0095	-.0095
	Y	+.0040	-.0040	-	.1540	-	.1565	
LOS2	X	+.0020	-.0020	+	.2745	+	.2722	.0003
	Y	+.0000	+.0000	+	.0000	+	.0002	+.0002
LOS3	X	+.0040	-.0040	-	.5510	-	.5515	
	Y	+.0000	+.0000	+	.0000	+	.0003	+.0003
LOS4	X	+.0000	-.0060	+	.5330	+	.5314	
	Y	+.0000	+.0000	+	.0000	-	.0000	-.0000

CENTER VIEW

DIAP	X	+.0000	-.0012	+	1.6120	+	1.6106	-.0002
	Y	+.0000	+.0000	+	.0000	+	.0001	+.0001
DIAP	X	+.0000	+.0000	+	.0000	+	.9091	+.9091
	Y	+.0000	-.0012	+	1.6120	+	1.6079	-.0029
THPL	X	+.0000	+.0000	+	.0000	-	10.2131	-10.21
	Y	+.0000	+.0000	+	.0000	-	1.5950	-1.595
	Z	+.0000	-.0016	+	.0961	+	.0961	

SEC. F-F

DEPA	X	+.0000	+.0000	+	.0000	-	10.4117	-10.41
	Y	+.0000	+.0000	+	.0000	-	1.0956	-1.095
	Z	+.0000	-.0020	+	.0576	+	.0547	-.0009
DEPB	X	+.0000	+.0000	+	.0000	-	10.5509	-10.55
	Y	+.0000	+.0000	+	.0000	-	1.3675	-1.367
	Z	+.0000	-.0060	+	.0556	+	.0510	
DEPC	X	+.0000	+.0000	+	.0000	-	10.5861	-10.58
	Y	+.0030	+.0000	+	.0000	-	2.1419	-2.141
	Z	+.0000	-.0060	+	.0556	+	.0506	
DEPD	X	+.0000	+.0000	+	.0000	-	10.7190	-10.71
	Y	+.0000	+.0000	+	.0000	-	2.3928	-2.392
	Z	+.0000	-.0020	+	.0576	+	.0543	-.0013

PART F

PLATE NO.1
FIRST LAMINA
F-17542221
DATE 4/16/76

		+TOL.	-TOL.		NOM.		ACT.	O.T.
LOCA	X	+.0000	+.0000	+	.0000	+	.0000	
	Y	+.0000	+.0000	[illegible]	.0000	+	.0000	
LOCB	X	+.0010	-.0010	-	.7480	-	.7486	
	Y	+.0010	-.0010	+	1.1968	+	1.1984	+.0006
LOCD	X	+.0012	-.0012	-	.3740	-	.3742	
	Y	+.0012	-.0012	+	.5984	+	.5994	
LOCN	X	+.0012	-.0012	-	.3740	-	.3740	
	Y	+.0012	-.0012	-	.0709	-	.0701	
HOLB	X	+.0085	-.0085	-	.2604	-	.2607	
	Y	+.0085	-.0085	+	.8565	+	.8577	
HL11	X	+.0085	-.0085	+	.0450	+	.0458	
	Y	+.0085	-.0085	+	.3229	+	.3242	
HL12	X	+.0056	-.0056	+	.2285	+	.2272	
	Y	+.0056	-.0056	+	.7559	+	.7567	
HL14	X	+.0056	-.0056	-	.2835	-	.2828	
	Y	+.0056	-.0056	+	.6494	+	.6482	
HL20	X	+.0000	+.0000	-	.2661	-	.2662	-.0001
	Y	+.0000	+.0000	+	.4153	+	.4154	+.0001
HL22	X	+.0040	-.0040	+	.2760	+	.2776	
	Y	+.0040	-.0040	+	.4034	+	.4030	
HL26	X	+.0040	-.0040	-	.7840	-	.7806	
	Y	+.0040	-.0040	+	.0717	+	.0702	
HL34	X	+.0056	-.0056	-	.4645	-	.4638	
	Y	+.0056	-.0056	+	.5474	+	.5470	
HL35	X	+.0040	-.0040	-	1.0240	-	1.0232	
	Y	+.0040	-.0040	+	.7934	+	.7931	
HL45	X	+.0040	-.0040	-	.8505	-	.8476	
	Y	+.0040	-.0040	+	1.0589	+	1.0591	
HL48	X	+.0040	-.0040	-	.4450	-	.4448	
	Y	+.0040	-.0040	+	1.1694	+	1.1707	
HL90	X	+.0060	-.0060	-	.4522	-	.4476	
	Y	+.0060	-.0060	+	.0613	+	.0599	
HL91	X	+.0060	-.0060	-	.5610	-	.5556	
	Y	+.0060	-.0060	+	.1311	+	.1303	
H103	X	+.0030	-.0030	-	1.0540	-	1.0544	
	Y	+.0030	-.0030	+	.4264	+	.4272	

```
        DIMENSIONAL C/L   CENTER LINE  HOLE 20
  CL20  X +.0003 -.0003 +  .2125 +  .2130 +.0002
        Y +.0000 +.0000 +  .0000 +  .0000

       SECT. C-C
  DPCB  X +.0000 +.0000 +  .0000 +  .5171 +.5171
        Y +.0000 +.0000 +  .0000 -  .1784 -.1784
        Z +.0015 +.0000 +  .0690 +  .0692

 [redacted]

  LOS1  X +.0000 +.0000 +  .0000 +  .0000
        Y +.0010 -.0010 -  .4480 -  .4460 +.0010

  LSL1  X +.0000 +.0000 +  .0000 -  .0142 -.0142
        Y +.0040 -.0040 +  .1540 +  .1573

  LOS2  X +.0000 +.0000 +  .0000 -  .0180 -.0180
        Y +.0010 -.0010 +  .4480 +  .4483

  LSL2  X +.0000 +.0000 +  .0000 +  .0000
        Y +.0040 -.0040 -  .1540 -  .1575

  LOS3  X +.0020 -.0020 +  .2746 +  .2746 -
        Y +.0000 +.0000 +  .0000 + -.0001 +.0001

  LOS3  X +.0040 -.0040 -  .5519 -  .5540
        Y +.0000 +.0000 +  .0000 +  .0000

  LOS4  X +.0000 -.0060 +  .5830 +  .5796
        Y +.0000 +.0000 +  .0000 +  .0000

        CENTER VIEW
  DIAP  X +.0000 -.0012 + 1.6120 + 1.6089 -.0019
        Y +.0000 +.0000 +  .0000 +  .0002 +.0002

  DIAP  X +.0000 +.0000 +  .0000 +  .0000
        Y +.0000 -.0012 + 1.6120 + 1.6097 -.0011

  THPL  X +.0000 +.0000 +  .0000 +  .0000
        Y +.0000 +.0000 +  .0000 -  .0002 -.0002
        Z +.0000 -.0016 +  .0961 +  .0960

        SEC. F-F
  DEPA  X +.0000 +.0000 +  .0000 +  .0612 +.0612
        Y +.0000 +.0000 +  .0000 +  .2094 +.2094
        Z +.0000 -.0020 +  .0576 +  .0551 -.0005

  DEPB  X +.0000 +.0000 +  .0000 -  .1565 -.1565
        Y +.0000 +.0000 +  .0000 -  .0659 -.0659
        Z +.0000 -.0060 +  .0556 +  .0531

  DEPC  X +.0000 +.0000 +  .0000 -  .3618 -.3618
        Y +.0000 +.0000 +  .0000 -  .7656 -.7656
        Z +.0000 -.0060 +  .0556 +  .0531

  DEPD  X +.0000 +.0000 +  .0000 -  .5171 -.5171
        Y +.0000 +.0000 +  .0000 - 1.0364 -1.036
        Z +.0000 -.0020 +  .0576 +  .0527 -.0029
```

READOUT

```
0      PLATE NO.1
0      FIRST LAMINA
0      F-10542821
0      DATE
0
0         +TOL.      -TOL.        NOM.        ACT.     Ø.T.
ELOCA .000,.000,+.000,-.000,+.000,-.000,
ELOCB -.749,+1.1968,+.001,-.001,+.001,-.001,
ELOCD -.374,+.5984,+.0012,-.0012,+.0012,-.0012,
ELOCN -.374,-.0709,,,,,,,,,,,,,,,,,,,,,,,,,
EHOLB -.2624,+.3565,+.0085,-.0085,+.0085,-.0085,
EHL11 +.045,+.3229,,,,,,,,,,,,,,,,,,,,,,,,,,,,
EHL12 +.2025,+.7559,+.0056,-.0056,+.0056,-.0056,,
EHL14 -.2835,+.6494,,,,,,,,,,,,,,,,,,,,,,,,,,,,
EHL20 -.0661,+.4153,+.000,-.000,+.000,-.000,
EHL22 +.076,+.4034,+.004,-.004,+.004,-.004,
EHL26 -.784,+.0717,,,,,,,,,,,,,,,,,,,,,,,,
EHL34 -.4645,+.5474,+.0056,-.0056,+.0056,-.0056,
EHL35 -1.024,+.7934,+.004,-.004,+.004,-.004,
EHL45 -.8505,+1.0589,,,,,,,,,,,,,,,,,,,,,,,
EHL48 -.445,+1.1694,,,,,,,,,,,,,,,,,,,,,,,,
EHL90 -.4522,+.0613,+.006,-.006,+.006,-.006,
EHL91 -.561,+.1311,,,,,,,,,,,,,,,,,,,,,,,
EH103 -1.054,+.4264,+.003,-.003,+.003,-.003,
0       DIMENSIONAL C/L   CENTER LINE  HOLE 20
ECL20 +.2125,.000,+.0003,-.0003,+.000,-.000,
0       SECT. C-C
FDPCB .000,.000,+.069,+.000,+.000,+.000,-.000,+.0015,-.000,
[redacted]
    ELOS1 .000,-.448,+.000,-.000,+.001,-.001,
ELSL1 .000,+.154,+,-,+.004,-.004,
ELOS2 .000,+.448,+,-,+.001,-.001,
ELSL2 .000,-.154,+,-,+.004,-.004,
ELOS3 +.2745.000,+.002,-.002,+.000,-.000,
ELOS3 -.551,.000,+.004,-.004,+.000,-.000,
ELOS4 +.583,.000,+.000,-.006,+.000,-.000,
0       CENTER VIEW
EDIAB +1.612,.000,+.000,-.0012,+.000,-.000,
EDIAB .000,+1.612,+.000,-.000,+.000,-.0012,
FTHPL .000,.000,+.0961,+.000,-.000,+.000,-.000,+.000,-.0016,
0       SEC. F-F
FDEPA .000,.000,+.0576,+.000,-.000,+.000,-.000,+.000,-.002,
FDEPB .000,.000,+.0556,+,-,+,-,+,-.006,
FDEPC .000,.000,+.0556,+,-,+,-,+,-,
FDEPD .000,.000,+.0576,+,-,+,-,+,-.002,
```

APPENDIX G

LIST OF PROJECT EQUIPMENT

LIST OF PROJECT EQUIPMENT

1. Image Dissector Optical Data Digitizer

2. Digitizer Power Supply

   EMR Photoelectric
   Model 658A
   Serial Number 29

3. Tungsten Halogen Lamp Source with Heat Exchanger

   Bulova Systems & Instruments Corp.
   Edmund Scientific
   Lamp
   Catalog Number 40, 780

4. Helium-Neon Laser Reflective Light Source (Part of EMR Digitizer)

   Spectra Physics
   Model Number 236
   Serial Number 3727/5285

5. Nova 3 Data General Computer (Part of EMR Digitizer)

   Data General Corp.
   Model Number Nova 3/12-8493
   Serial Number SO #6206-1 516
   Option 4010

6. ASR Model 33 Teletype Machine

   Teletype Corp.
   Model Number 3320-3WE
   (No obvious serial number)

7. Video Monitor (Part of EMR Digitizer

   Tektronix Corporation
   Model Number 604
   Serial Number B121609

8. Anorad X-Y Table (Part of EMR Digitizer)

   Anorad Corporation
   Model 108
   Serial Number 01 (Job Number 108)
   10" X-Travel, 4" Y-Travel

9. Automatic Loader and Unloader w/Precision Lamina Holding Fixture

   Bulova Systems and Instruments Corp.
   Model/Project Number 929
   Serial Number 01

10. Texas Instruments 5TI Programmable Controller Sequencer

    Texas Instruments Corporation
    Model 5TI-1023
    Serial Number 102-631 RE/MFG

11. I/O Interface with Logic Modules

    Bulova Systems & Instruments Corp.
    Model/Project 929

    Contains the following Logic Modules:

    5TI5 Logic Module
    16 output
    Model 5TI 5020
    Serial Number 1961

    5TI5 Logic Module
    16 output
    Model 5TI5 5020
    Serial Number 1929

    5TI5 Logic Module
    8 in/8 out
    Model 5TI 5011
    Serial Number 3043

    5TI5 Logic Module
    16 input
    Model 5TI 5010
    Serial Number 3901

    5TI5 Logic Module
    16 input
    Model 5TI 5010
    Serial Number 3892

12. Software Package

    EMR Corporation
    NOVA 3 Program Tape
    Serial Number 7